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Full Length Research Paper

Supply chain management of anti-malarials in the district hospitals in Kumasi Metropolitan Area, Ashanti region of Ghana

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The aim of the study was to assess the supply chain management of anti-malarials in the five district hospitals in the Kumasi Metropolitan Area (KMA) including the Regional Medical Store (RMS) and also to assess the level of knowledge of respondents on malaria in these facilities. Cross sectional study was conducted at the facilities and purposeful sampling technique was applied to select the clients and interviewed. All the hospitals sourced their anti-malarials from the regional medical store (RMS) with tablet artemether-lumefantrine, tablet artesunate-amodiaquine, injection artesunate and sulphadoxinepyrimethamine (SP) being dispensed by all the hospitals from January to December 2015. All health facilities transport their anti-malarials from RMS by vans. The commonly known anti-malarials by respondents were tablet artemether-lumefantrine (84.08%, n=169) and tablet artesunate-amodiaquine (81.09%, n =163), with 5.47% (n =11) of respondents not knowing any type of anti-malarial. Antimalarials used for the treatment of malaria was given to 65.67% (n=132) of the clients at the hospital. Most of these anti-malarials were available at the hospitals though some facilities encountered periodic shortages and also had stocks expiring within the studied period. Respondents had fair knowledge of the side effects of a few of the anti-malarials. There is a need to ensure proper and effective supply chain management of these anti-malarials in these hospitals to maintain adequate quantities of these medications in these hospitals and RMS.

Key words: Malaria, anti-malarial, supply chain management, plasmodia, female anopheles mosquito.

INTRODUCTION

Malaria is a major global problem and has devastating effects on health and development, especially on the poor and marginalized in most low-income countries. WHO estimated that in 2010, there were 219 million

cases of malaria resulting in 660,000 deaths. For most of the estimated cases, 80% occurred in sub-Saharan Africa (WHO, 2011). Malaria is one of the leading causes of illness in Ghana and the major cause of morbidity and mortality, especially among the under 5 years and pregnant women. It accounts for over 3 million outpatient visits to public health facilities annually (Steketee et al., 2001).

Due to the financial and health importance of malaria as a major public health problem, a good supply chain management system should be the key to ensuring that, anti-malarials are actually available at the point of care (Williams et al., 2004; Amin et al., 2007; Hussain et al., 2013). Supply chain management includes all the activities that must take place to get the right product to the right consumers hand in the right quantity at the right time. Simply, the chain of events is from the raw materials to the end user. To realize this, a highly managed and functioning supply chain system should be in place to help deliver quality products on time to end users (Croxton et al., 2002).

One major health challenge confronting Africa is the effective treatment of malaria, bearing in mind the fact that it claims the lives of more than one million people each year, mostly pregnant women and children under the age of five (Gelband and Stansfield, 2001; Creel, 2002). In addition to its potential mortality, malaria places a heavy economic burden on many endemic countries. Africa alone makes a yearly direct loss of approximately US$12 billion due to malaria from such indicators as the illness itself, treatment and premature death. Also, more than that is lost in economic growth due to malaria prevalence (Malaria No More, 2009).

There is a major socio-economic challenge to African countries due to malaria and this challenge needs to be curtailed since good health is not only a basic human need but also a fundamental human right and a compulsion for economic growth (Streeten, 1981; Asante and Asenso-Okyere, 2003). In line with this, artemisinin-based combination therapy (ACT) has been adopted by over 40 countries in Africa as the first line treatment recommendation for uncomplicated malaria (Cohen et al., 2005).

Ensuring high standards for medicines as well as medical treatment will be essential in preserving the efficacy of the current first line treatment, that is, ACT. Although, funding in the public sector has increased remarkably over the years, Paterson and Obileye (2002) reported that most treatments are administered over-the-counter through hospital and community pharmacies, chemical shops and hawkers. Because these outlets are not adequately regulated, there are substantial variations in the distribution, quality, price and administration of these anti-malaria drugs (Amin and Kokwaro, 2007). There is no doubt that resistance to artemisinin has already been established in places like South East Asia and this could spread to Africa (Ashley et al., 2014; Tun et al., 2015). Likewise, there is a reported high level resistance to sulphadoxine-pyrimethamine (SP) in South America, South Asia (Wongsrichanalai et al., 2002; Lin et al., 2010), East and South Africa (Lin et al., 2010; Ringwald, 2014). The problem of drug resistance could be attributed to inappropriate use of drugs, lack of medical supervision, weak public health system, shortage at government clinics or even lack of access, and all these could be linked to the supply chain system for the ACT (Asamoah et al., 2011).

All of these factors can be identified with the supply chain system of ACT in Ghana and by implication, the potential high-risk of drug resistance in the country. In Ghana, essential medicines are defined within the National Drugs Policy framework (2004) and procured through the public procurement arrangements, which are regulated by various acts and legislations. They are received by the publicly owned Central Medical Stores (CMS) for warehousing and distribution to the various regional medical stores (RMS) and health facilities in the public and private sectors. Under this procurement arrangement, all health facilities are also allowed to procure outside the CMS within an agreed threshold value (MOH, 2006).

A supply chain is that network of organizations that are involved, through downstream associations, in the different processes and activities that produce value in the form of products and services in the hands of the ultimate consumer (Christopher, 2005). The three primary components of supply chain management (SCM) are information, logistics and finance (Lyson and Farrington, 2006).

The unique nature of the supply chain for pharmaceuticals makes managing complex information for supply chain effectiveness challenging, but clearly the rewards for doing so are significant. Lack of proper information mechanism may lead to poor inventory control methods, which tend to affect transportation costs (Mustaffa and Potter, 2009). Supply chain vulnerability is due to five main factors- delays, disruptions, price increases, operations and legislation. Ranking these factors against standard criteria of occurrence, controls and impact, will help to identify the factor which most identifies with the vulnerability.

Delays in the supply chain have a direct impact on a company's profit (Li et al., 2006). Product discontinuity, product shortages, poor performance, patient safety/

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dispensing and technological errors (causing stock shortages in pharmacies) are identified as risks associated with pharmaceutical supply chain at the basic level (Breen, 2008). These risks cause delays in the system and eventually dissatisfy the final consumers or patients. All these incur risk through disruption to the supply chain system (Breen, 2008).

The main aim of this study is to assess the supply chain management system of anti-malarials in five district hospitals in the Kumasi Metropolitan Area (KMA) of Ashanti region, Ghana; and also to assess the level of knowledge of respondents on malaria in these facilities.

METHODOLOGY

Study design

A cross-sectional study was conducted at the Ashanti Regional Medical Store (RMS) and all the district hospitals in Kumasi Metropolis, Ghana. The ethical approval for the study was approved by the Faculty of Pharmacy. Ethical Review Committee (approval number: Pharm/EthC/X812015), Kwame Nkrumah University of Science and Technology, Kumasi, Ghana.

Setting

The study involved six (6) health facilities (the Regional Medical Store (RMS) and the five (5) district hospitals) and a total of two hundred and one (201) clients representing 20% of the total number of clients coming from each of the five district hospitals (Maternal and Child Hospital (MCH), Tafo Hospital, Suntreso Hospital, Kumasi South Hospital (KSH) and Manhyia Hospital). Participants included in the study were all pharmacists practicing in the selected facilities and clients (aged 18 years and above) seeking health care in the selected district hospitals. The purposeful sampling technique was applied to select the clients and interviewed. Permission to conduct the study in the selected health facilities was sought from the respective medical superintendents/directors and their management teams of the hospitals.

Data collection

The data collector/interviewer explained the purpose of the survey to the respondents and made clear that it was optional or voluntary and the respondent was assured of anonymity and confidentiality and informed consent form signed by the respondent. The sampling method used for the survey among the respondents was purposive technique. The trained interviewer also carried a copy of the printed document shown to each interviewee and his identification (ID) card. The interviews were conducted during the period of 25th May to 9th July, 2016. A validated, semi-structured questionnaire was employed to solicit information from the respondents. The data was collected from the respondents via face-to-face interviews in the selected health facilities. The average length of time taken to complete each interview was 40 min for the pharmacists and 10 min for the clients. The respondents were presented with show card for the questions.

Data analysis

Data was coded, entered into MS Excel software (Microsoft Inc., Redmond, WA, USA) and analyzed.

RESULTS

Facilities stocking pattern and sourcing

All facilities stocked tablet artemether-lumefantrine, injection artesunate and SP. Eighty three percent (83%, n = 5) and 33% (n = 2) of the facilities stock dihydroartemisinin-piperaquine and tab quinine, respectively. Suspension quinine and injection quinine were stocked by 50% (n = 3) of the facilities. However, only Manhyia stocked suspension artesunate-amodiaquine. All the hospitals sourced their anti-malarials from the regional medical store. MCH however procured from the open market in addition. The Regional Medical Store sources its anti-malarials from central medical store.

Quantities of anti-malarials dispensed from facilities

Tablet artemether-lumefantrine, tablet artesunate-amodiaquine, injection artesunate and SP were dispensed by all the facilities in the year under review. In addition, injection quinine and tab quinine were dispensed at MCH while suspension artemether-lumefantrine and suspension quinine were also dispensed at Tafo Hospital (Table 1).

Stock Levels of anti-malarials

The quantities of the various anti-malarial drugs present at the health facilities considered in the study at the end of December, 2015 were determined (Figure 1).

Prescription pattern

The most prescribed anti-malaria by all the facilities was tab artemether-lumefantrine. The least prescribed by Tafo and Suntreso were amodiaquine suspension and tablet, respectively. Tab Quinine, SP and inj Quinine were the least prescribed at MSH, KSH and Manhyia, respectively.

Stock run out documentation

Suntreso and KSH ran out of tab artesunate-amodiaquine within the year. Manhyia ran out of injection Quinine. Also, there was a run-out of suspension artesunate-amodiaquine at Tafo and susp artemether-lumefantrine at Manhyia and KSH in 2015. There was also a run out of SP at suntreso and Tafo and tab quinine at suntreso and Manhyia. KSH and Manhyia reportedly ran out of susp quinine. The RMS also ran out of inj Quinine, inj Artesunate and SP in 2015.

Table 1. Quantities of the various anti-malarials dispensed at the facilities

	KSH	MCH	Manhyia	Tafo	Suntreso
Tab A/L	24190	5015	13586	4535	7845
Susp A/L	-	-	-	7701	-
Tab A/A	1078	365	1345	1745	1403
Inj Quinine	-	60	-	-	-
Tab Quinine	-	2000	-	-	-
Susp Quinine	-	-	-	31	-
Inj Artesunate	9180	1985	8654	1023	6540
SP	9600	3010	14000	14470	12207

KSH: Kumasi South Hospital; MCH: Maternal and Child Health Hospital; Tab A/L: tablet artemether-lumefantrine; Susp A/L: suspension artemether-lumefantrine; Tab A/A: tablet artesunate-amodiaquine; SP: tablet sulphadoxine-pyrimethamine

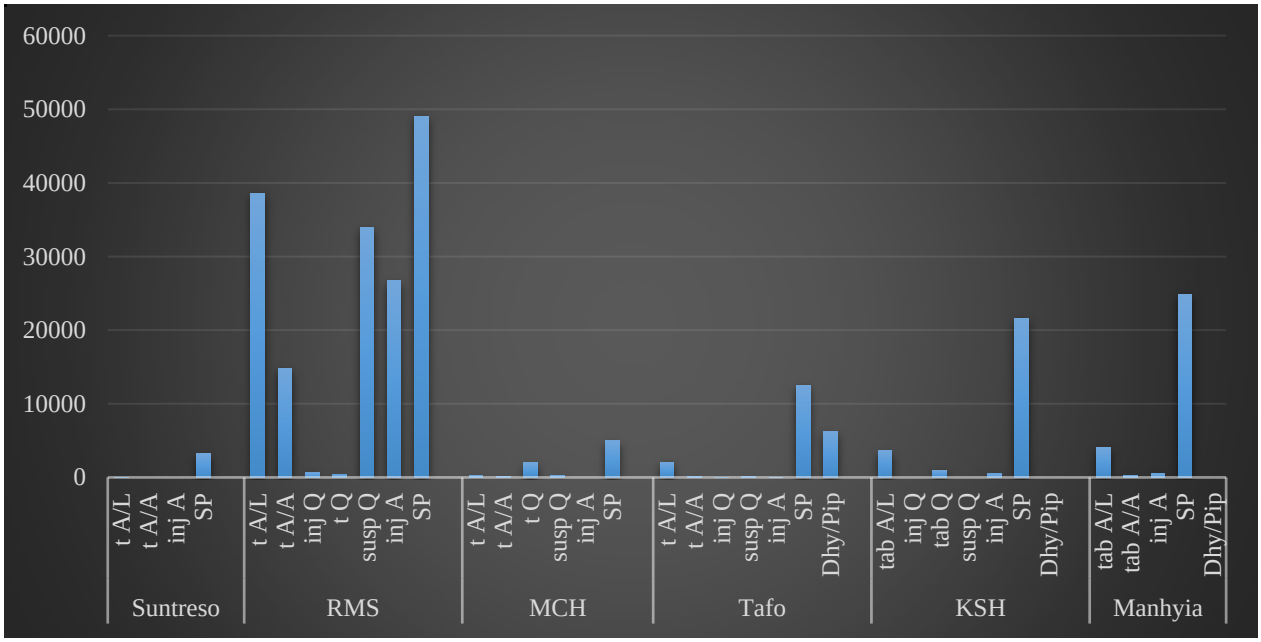

Figure 1. Stock levels of antimalarials. RMS: Regional Medical Store; KSH: Kumasi South Hospital; MCH: Maternal and Child Health Hospital; Tab A/L: tablet artemether-lumefantrine; Susp A/L: suspension artemether-lumefantrine; Tab A/A: tablet artesunate-amodiaquine; SP: tablet sulphadoxinepyrimethamine.

Suntreso ran out of these anti-malarials for a period exceeding 3 months. While Manhyia, KSH and Tafo experienced these shortages for up to 3 months.

Expiration of anti-malarials

RMS, MCH and Tafo had cases of anti-malarials expiring within 2015. All three facilities had stocks of tab artesunate-amodiaquine expiring with the study period. With Tafo also recording expirations for inj Quinine and tab Quinine, Manhyia had Dihydroartemisinin-piperaquine expiring with the study period.

Means of transport and storage of anti-malarials

All health facilities transported their anti-malarials from RMS by van. The RMS likewise received anti-malarials from CMS by van. Anti-malarials were stored in temperature-regulated rooms by all health facilities considered in the study. Only KSH and RMS however did have softwares for managing anti-malarials in and out-flow at their facilities.

Regional medical store's distribution pattern

RMS distributed range of anti-malarials to health facilities

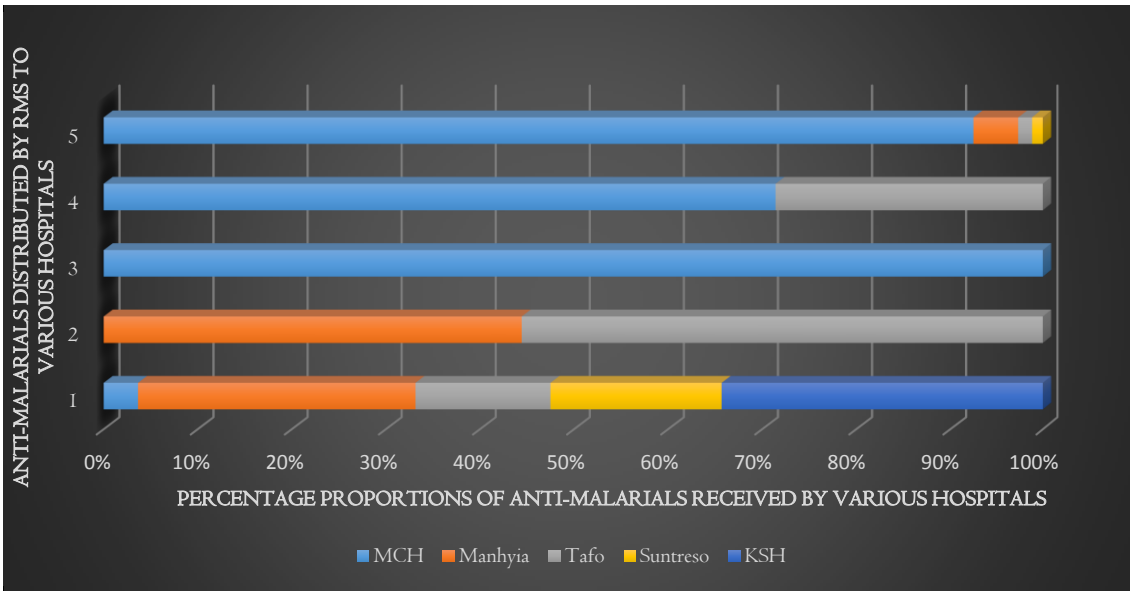

Figure 2. Distribution pattern of anti-malarials from Regional Medical Store (RMS) to hospitals. 1: Tablet artemether-lumefantrine; 2: Tablet artesunate-amodiaquine; 3: Tablet quinine; 4: Suspension quinine; 5: Injection artesunate; KSH: Kumasi South Hospital; MCH: Maternal and Child Health Hospital.

considered in the study, with the respective quantities documented in Figure 2.

Respondents' knowledge on malaria

Eighty percent (n = 161) of the respondents defined malaria as just a condition marked by fever. Sixteen percent (n = 33) however defined it as a disease caused by mosquito bite. Malaria was defined as a condition marked by headache and body pains by 1% (n = 1) of the respondents. One percent (n = 1) of the respondents also believed malaria is caused by contaminated food; with 1% (n = 1) also believing malaria to be caused by both mosquitoes and contaminated food (Figure 3).

Classification of malaria

About ninety-six percent (n = 192) of the respondents did not know the various classifications of malaria (uncomplicated or complicated). However, one respondent knew of simple malaria (Figure 4).

Symptoms of malaria as reported by respondents

Fever was the most known symptom of malaria, being reported by 78.11% (n = 157) of the respondents. About seventy-two percent (n = 144) of the respondents also knew that bodily pains is associated with malaria. Some of the symptoms of malaria respondents gave included chills, anorexia, body weakness, abdominal pains and diarrheoa (Figure 5).

Types of anti-malarials

The commonly known anti-malarial drugs by respondents were tab artemether-lumefantrine (84.08%, n = 169) and tab artesunate-amodiaquine (81.09%, n = 163). However, susp artemether-lumefantrine, susp artesunate-amodiaquine, inj quinine, tab quinine, inj artesunate and SP were known by respondents. About two percent (n = 4) of the respondents knew of herbal anti-malarials as well with 5.47% (n = 11) of respondents not knowing any type of anti-malarial (Figure 6).

Side effects of anti-malarials as known by respondents

The commonest side effects of anti-malaria drugs were vomiting and nausea, reported by 28.36% (n = 57) and 21.89% (n = 44) of the respondents, respectively. Other side effects known by respondents include anorexia, dizziness, weakness, itchiness and sleep disturbances. About twenty-three percent (n = 46) of respondents, however, did not know any side effects of anti-malaria drugs (Figure 7).

How often do respondents get malaria

Seventy-nine of the 201 respondents did get malaria once in the past three months with 35 respondents getting it twice within that period. However, 54 respondents did not get malaria within the past three months (Figure 8).

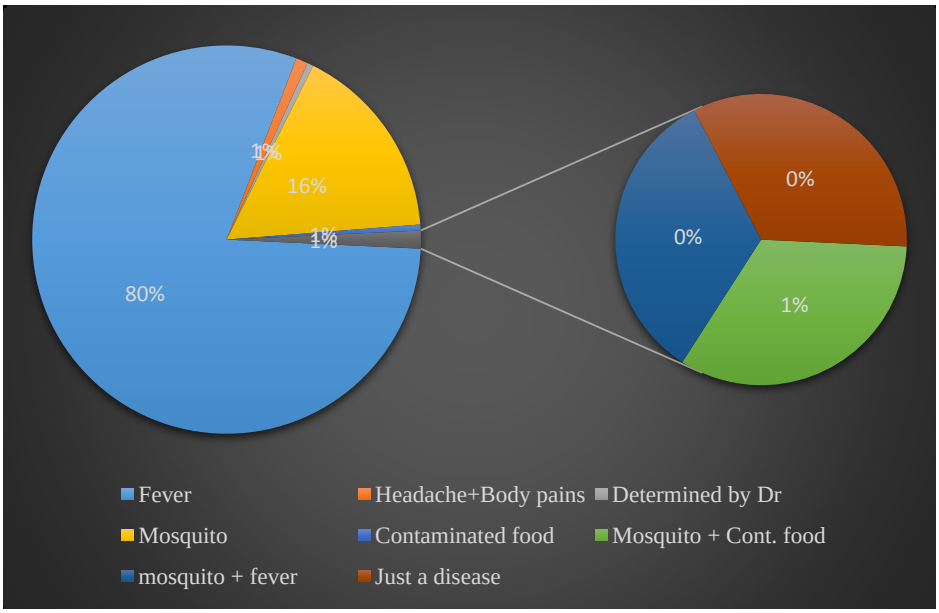

Figure 3. Respondents' knowledge on malaria. Dr: Medical officer; Cont. food: contaminated food

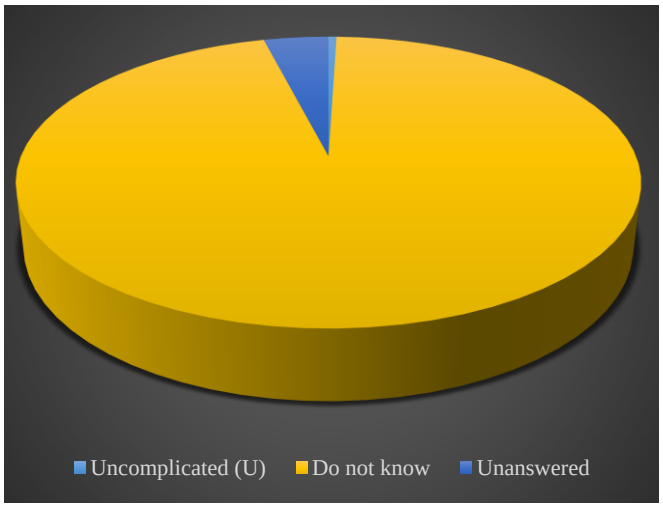

Figure 4. Classification of malaria.

Anti-malarials taken by respondents

About sixty percent (n = 121) of respondents who got malaria within the past three months took tab artemether-lumefantrine, at least once, within that period. The second most used anti-malarial by respondents was tab artesunate-amodiaquine by 24.39% (n = 49) of respondents.

However, 6.97% (n = 14) of respondents did not remember the anti-malarial they took within that period. Herbal preparation (0.50%, n = 1) and SP (0.50%, n = 1) were also taken by some respondents with the study period (Figure 9).

Source of anti-malarials used within the past three months by respondents

Anti-malaria drugs used for the treatment of malarial was given to 65.67% (n = 132) of the clients at the hospital. About thirty-four percent (n = 69) of clients also purchased these anti-malaria drugs from the pharmacy with 4.48% (n = 9) obtaining them from the chemical shop (Figure 10).

DISCUSSION

The procurement and supply directorate is mandated to formulate policies on procurement and supply chain. It coordinates central procurement and supervises the management of the central medical stores. The central medical stores, which is one of the three units of the procurement and supply directorate, receives, stores and distributes goods meant for agencies of the ministry of health. Again, they monitor the supply chain to ascertain timeliness and quality of goods (MOH, 2012). It comes with no surprise from this survey that the regional medical store procures its anti-malarials from the central medical store. Periodic shortages of anti-malarials in the supply chain mechanism of the ministry of health can, however, account for the procurement of anti-malarials by some hospitals from the open market.

With a lot of reports on the untoward side effects of artesunate-amodiaquine (Adjei et al., 2009), the first line

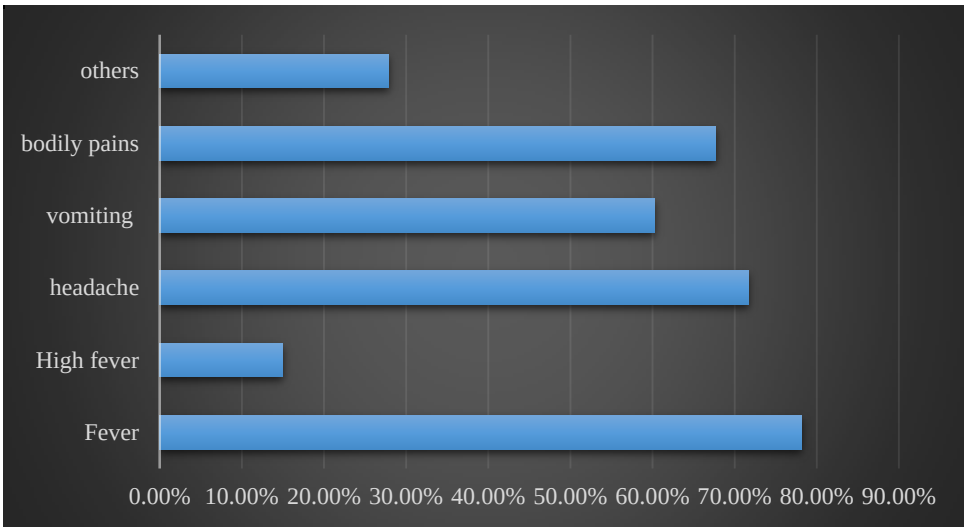

Figure 5. Symptoms of malaria as provided by respondents.

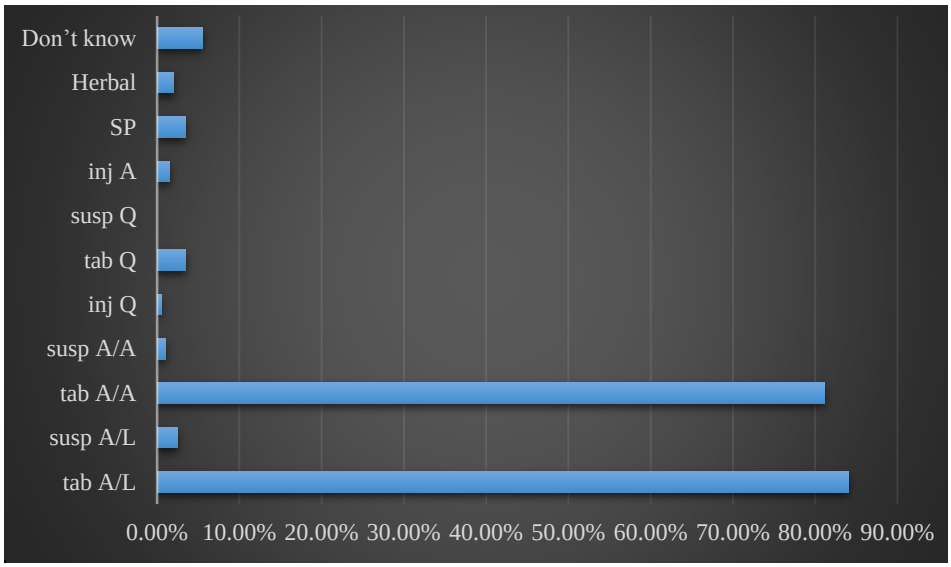

Figure 6. Types of anti-malarials as reported by respondents. Tab A/L: tablet artemether-lumefantrine; Susp A/L: suspension artemether-lumefantrine; Tab A/A: tablet artesunate-amodiaquine; inj A: injection arthemether; SP: tablet sulphadoxine-pyrimethamine; inj Q: injection quinine; tab Q: tablet quinine

treatment, it came with no surprise that artemether-lumefantrine was the most prescribed anti-malarial by the health facilities. This is because most individuals do find the side effects of artemether-lumefantrine to be tolerable (Chatio et al., 2015).

Distribution pattern for anti-malarials by regional medical stores to the various hospitals shows that Manhyia and Kumasi South Hospital may have higher cases of malaria within the period of study. Worryingly, a very high supply pattern of supply of suspension and tablet quinine and inj artesunate to MCH may be an indication of continual incidence of severe malaria in pregnancy and children. This is a public health concern and attempt to reduce malaria in pregnancy and in infants should be intensified.

There were observed and recorded cases of drug expiration before stock run-outs. This is a public health concern since the ideal target for annual expired product value would be \$0.00 or 0% (USAID/DELIVER PROJECT, 2003). This may be difficult to achieve,

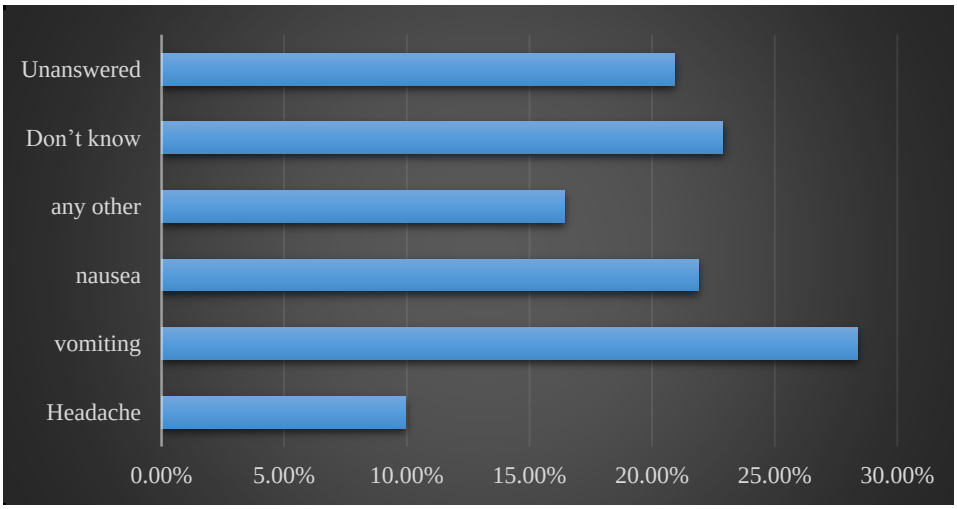

Figure 7. Side effects of anti-malarials as reported by respondents.

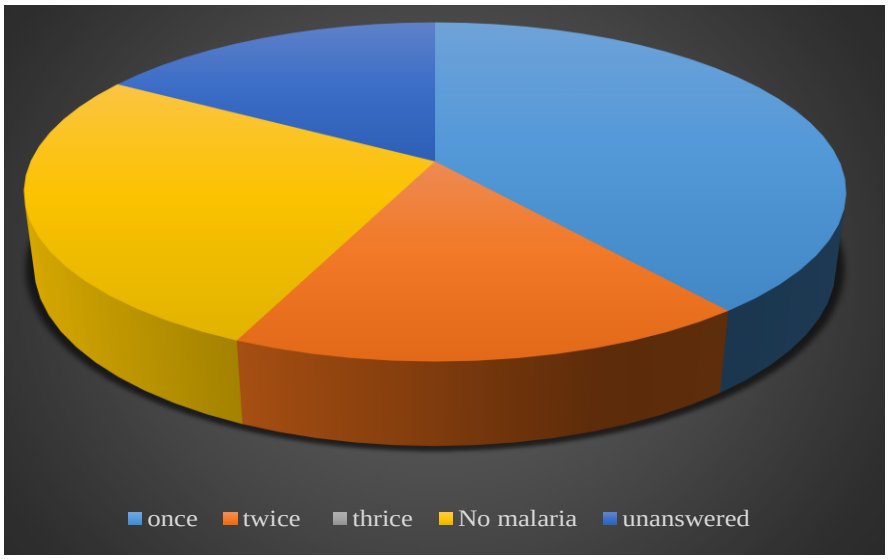

Figure 8. How often did respondents get malaria in the past three months.

however, given the various factors that contribute to product expiration. The inventory management unit should review historical information on annual product expiration values and establish a relevant target value for annual product expiration (USAID/DELIVER PROJECT, 2003).

With observed stock run-out in some facilities, the root cause may be ineffective supplier performance and poor forecasting by procurement teams of the hospitals. The ideal target for supplier product performance is 100%. However, some suppliers may not be achieving this target. In these cases, the procurement unit should review past performance and establish a baseline target rate for the supplier's performance. This rate should be set at a level above the current performance level so that it raises the supplier's performance expectations and encourages a process of continuous improvement. The target level should be raised appropriately as performance improves, aiming to achieve 100% over time (USAID/DELIVER PROJECT, 2003). To improve supplier performance, identify the areas of non-compliance to the supplier with a request for a corrective action plan and implementation schedule. It is worthwhile to provide positive feedback to the supplier to acknowledge the good/improving performance and encourage continued supplier commitment to providing product quality and service when there is a curb of stock run-out eventualities.

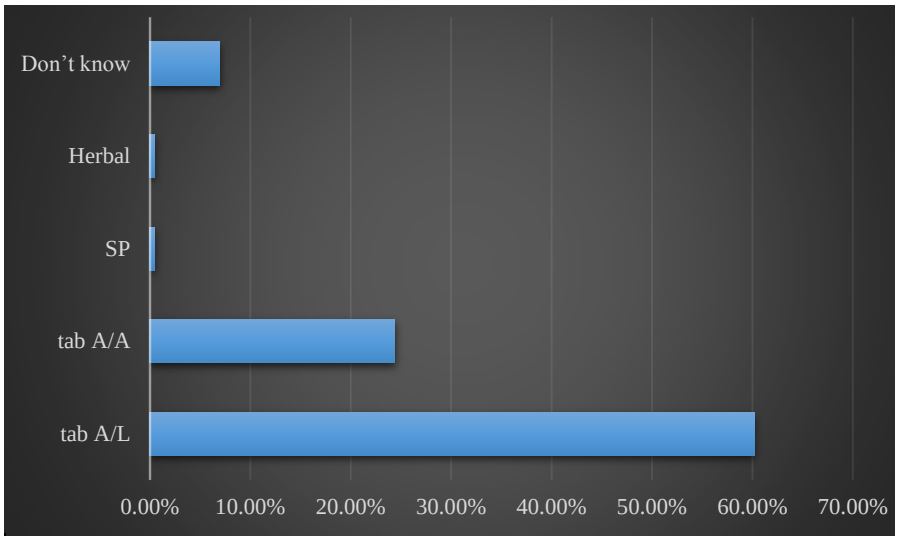

Figure 9. Anti-malarials taken by respondent within the past three months.

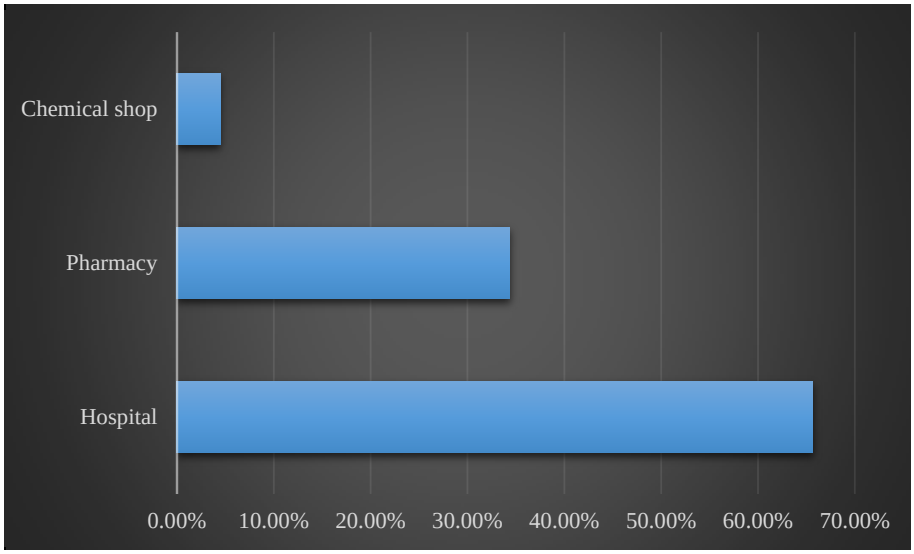

Figure 10. Sourcing of anti-malarials by respondent within the past three months.

Clients/respondents have a fair knowledge on what malaria is and some signs and symptoms of malaria.

However, the majority of the clients/patients at these health facilities had no idea of the two main types of malaria illness. It is understandable that most of the clients knew about artemether-lumefantrine and artesunate-amodiaquine, since these are the commonly prescribed anti-malarials in most health facilities for uncomplicated malaria and are actually a policy recommendation.

The side effects of these anti-malarials were observed by a significant number of clients who take them. There were also recorded cases of multiple malaria cases within three-month period. This could be attributed to number of reasons such as non-compliance with therapy regiment, failed drug therapy, breeding of mosquitoes in unsanitary conditions. In Ghana, with a failure rate of two-fifth of infected individuals, the patient has an approximately two-third chance of obtaining medicine of good quality (WHO, 2011). This shows that failed drug therapy could be a possibility.

It is however commendable that many individuals know about the prescribed anti-malarials with a high number of them obtaining these anti-malarials from the hospital pharmacies and community pharmacies where they are attended to by qualified personnel including pharmacists

and pharmacy technicians.

Working together, the planning/procurement/inventory management units of the RMS as well as the procurement teams at the various hospitals should identify activities where problems contributing to product expiration might occur. Such activities may include, the forecasting accuracy; inventory practices such as first-in first-out (FIFO); accurate stock on hand against inventory records; supplier adherence to expiration date requirements; supplier adherence to delivery dates etc. This information can be used to identify areas where improvements can be made. For effective corrective action to occur, it is important to identify the root cause of product expiration.

Conclusion

The same anti-malarials were dispensed or available in the studied facilities and they were available at the hospitals though some did encounter periodic shortages and also have some stocks expiring within the period considered in the study. Most of the facilities lacked software for efficient tracking of anti-malarial flow in the health facilities. Respondents did have considerable knowledge on malaria and its signs and symptoms. Also, they had fair knowledge on the side effects of some of the anti-malarials.

CONFLICT OF INTERESTS

Authors declare no conflict of interest.

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Full Length Research Paper

The assessment of fever in under-five children in the Ekounou Health Area of Yaounde, Cameroon: Usefulness of rapid diagnostic tests

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Improper diagnosis and management of febrile patients results in the persistence of malaria and other conditions with similar symptoms. The algorithm established here with Rapid Diagnostic Tests (RDTs) will help in the follow-up and treatment of fever patients according to the guidelines on Integrated Management of Childhood Illness (IMCI). This study aimed at determining the causes of fever in children and at valorizing the use of RDTs for the diagnosis of febrile diseases. Fifty children with fever, aged between 0 and 5 years, were recruited in a cross-sectional study at the Ekounou Baptist Clinic in Yaounde. RDTs were used to assess for the four common causes of febrile illness in the area. Microscopy was done and the *Plasmodium* species were confirmed by nested Polymerase Chain Reaction (PCR). Of the 50 febrile children, none was rubella seropositive, while 8% had malaria, 22% had toxoplasmosis infection, 8% had *Salmonella typhi*, 14% had a malaria-typhoid fever co-infection, 4% had a malaria-toxoplasmosis co-infection, 6% had a malaria-toxoplasmosis-typhoid fever co-infection, and 38% were negative for all the suspected common causes of fever in the health district. The overall frequencies of occurrence attributed 32% to malaria, 32% to toxoplasmosis and 28% to typhoid fever. Among all the positive malaria cases (n=16 (32%)) *Plasmodium falciparum, Plasmodium malariae* and *Plasmodium ovale* were identified by nested PCR. Malaria RDT results agreed significantly with the microscopy (kappa=0.81; $p<0.0001$) and PCR (kappa=0.84; $p<0.0001$) results; and the microscopy results also concurred significantly with the PCR results (kappa=0.77; $p<0.0001$). Malaria was not the exclusive cause of fever. Toxoplasmosis was found to occur in the same proportion as malaria (32%) in the study population. *S. typhi* was the third most important infection. Therefore RDTs are appropriate tools for the management of childhood febrile diseases.

Key words: Fever, malaria, toxoplasmosis, typhoid, rubella, rapid diagnostic test (RDT), Cameroon.

INTRODUCTION

Fever is a nonspecific response to various types of infectious and/or non-infectious stimuli; and the factors that provoke it constitute its pyrogenic profile. In sub-Saharan Africa, fever remains a major public health problem since it is a particularly predominant symptom in children less than 5 years old (Nnedu et al., 2010) and a

frequent reason for parents to seek primary care. In Cameroon, its prevalence in children of this age range was 42.2% in 2010, and it did not vary with age or gender (INS, 2010). Fever has been shown to be the main clinical manifestation of malaria in endemic areas, where transmission is intense, the burden of the illness is greatest and where severe disease and mortality are largely registered. The Cameroon National Malaria Control Program defined the most vulnerable group of people to be children, with 56 and 52% cases of malaria listed in 2008 and 2010 respectively (PNLP, 2011). Malaria treatment is often dispensed on the basis of "fever" and other associated symptoms (chills, headache, vomiting), rather than on parasitologically confirmed diagnosis. The policy of presumptive treatment of malaria for all febrile illnesses had also been widely advocated in sub-Saharan Africa prior to the advent of better diagnostic procedures. However, such presumptive therapy results in significant overdiagnosis and overtreatment (WHO, 2008). Secondly, the use of antimalarials without confirmation by biological tests provides approximate treatment, thus further incriminating the already condemned notion of self-medication. This could eventually lead to heavy consequences on resistance to the recently introduced artemisinin-based combination therapies (ACTs - sulfadoxine pyrimethamine, atovaquone-proguanil, etc.). Furthermore, the resulting poor management of non-malarial pathologies takes a heavy toll on family income. Most importantly, the delays in the etiological diagnosis of non-malarial fevers can have serious consequences on the patient (Amexo et al., 2004; Barnish et al., 2004; Nankabirwa et al., 2009). Many other diseases such as typhoid fever, pneumonia, toxoplasmosis, rubella and other bacteraemia are very often misdiagnosed for malaria because of their very similar clinical manifestations, making their differentiation difficult (Redd et al., 1992; Prasad et al., 2015). With reports of the decline in the incidence of malaria in many African countries (Bouyou-Akotet et al., 2009; Delacollette et al., 2009; Satoguina et al., 2009), it is imperative that parasite confirmation of malaria be scaled up in all age groups. Rapid diagnostic tests (RDTs) are cheap and practical for improving on the diagnosis and treatment of malaria and have been adopted as a public health policy in several African countries (Reyburn et al., 2007; Bisoffi et al., 2009; Bastiaens et al., 2011). The causes of non-malarial fevers can then be followed up and managed appropriately (Oladipo and Wellington, 2013). To determine the causes of fevers in the Ekounou Health Area, about 6 km from the centre of Yaounde, this study sought to evaluate clinical, parasitological, molecular and RDT data in order to provide an algorithm for fever management.

MATERIALS AND METHODS

Study population and sample collection

At the Ekounou Health Clinic of the Cameroon Baptist Convention, by convenient sampling, a total of 50 children were recruited consecutively for a cross-sectional study during the period of February to April 2013. The children were enrolled if they met the following criteria: 6 to 60 months of age, documented fever at presentation or history of fever in the last 24 h (rectal temperature ≥ 37.5ºC or axillary temperature ≥ 38ºC), absence of signs of complicated/severe malaria or any known serious chronic disease (to avoid the rapid deterioration of the state of such children which is common if not promptly contained), and the willingness of the parent/guardian to grant a written assent. Those that presented with signs of complicated malaria such as convulsion/coma, prostration, and/or severe vomiting, were excluded and managed appropriately or referred to the next level of healthcare in the area. The Case Report Form (CRF) that documented axillary body temperature, history of fever and other presenting symptoms was completed for each patient before venous blood puncture.

Ethical issues

Ethical clearance for the study was obtained from the Cameroon National Ethics Committee in a project entitled "An equity and cost effectiveness analysis strategy for the deployment of artemisinin-based combination therapy (ACT) at the community level'' (N°113/CNE/SE/2011). The participation in this study was proposed to every parent/guardian who brought his child to the clinic for reasons of fever. After information and response to all enquiries those who authorised the participation of their children concretised their agreement by signing the assent form.

Sample collection

The clinical and anthropometric parameters of each child were measured, followed by venous puncture under aseptic conditions for the collection of 3 ml of blood in Ethylene Diamine Tetra-acetic Acid (EDTA) tubes. From the total blood, 2 slides were immediately prepared for microscopy (thick and thin blood smears), and some drops were used to determine the random blood sugar and haemoglobin levels. Some more drops were also used for RDTs (malaria, typhoid fever), while a last few were deposited on filter paper and dried at room temperature for Deoxyribonucleic Acid (DNA) extraction. The remaining blood found in the EDTA tubes was centrifuged thereafter at 20 000 rpm for 5 min to collect plasma, part of which was used for the rapid diagnosis of rubella and toxoplasmosis. The remaining part was preserved at -20°C for further use

Disease diagnosis by RDTs

For each child enrolled, one-step RDTs were carried out on total blood for malaria (*SD BIOLINE Malaria Ag Pf/Pan*) and typhoid

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fever (*OnSite Typhoid IgG/IgM Combo Rapid Test*) and on plasma for rubella (*Rubella* ^{TM}) and toxoplasmosis (*OnSite Toxo IgG/IgM Rapid Test)*. Were performed as recommended in the manufacturers' guidelines found in the kits. The Malaria RDTs detected the Histidine-Rich Protein II (HRP-II) and *Plasmodium* Lactate Dehydrogenase (*p*LDH) antigens that are specific for Plasmodium species, while the 3 others (for typhoid, rubella and toxoplasmosis) detected Immunoglobulin M (IgM) and Immunoglobulin G (IgG) antibodies in blood and plasma. The choice of the 4 RDTs was guided by the increased frequency of these illnesses in the region and there was an anecdotal claim of a rubella outbreak (INS, 2010).

Parasitological diagnosis of malaria

Venous blood from each child was used to prepare thick and thin smears on 2 slides each. The thin films were fixed with absolute ethanol and left to dry. The prepared smears were stained with 10% Giemsa at pH 7.2 for 15 min. The parasite density was calculated as the number of parasites per 200 leucocytes on a thick film and reported as parasites per microliter of blood, assuming an average white blood cell count of 8000/µL (Greenwood and Armstrong, 1998). Stained slides were examined under a light microscope using the 100X objective with immersion oil. A slide was considered negative after 100 high power fields (HPF) were examined and two other microscopists reread the slides for confirmation. Parasite counts with more than 20% discordance between two readers were reread by a third person, who served as the tie breaker. The counts with less than 20% discordance between the first and second readers were accepted and the mean parasite count taken to compute the parasite density or parasitaemia for each child.

Measurement of biological parameters

Glycaemia and haemoglobinemia were measured using *OneTouch Ultra 2* and *URIT-12-Hemoglobin Meter* kits respectively and performed as recommended by the manufacturers, knowing that the normal range of blood glucose is 70 to 110 mg/dL and for the age- and gender-dependent total haemoglobin levels: Male adults (13.5-18.0 g/dL), female adults (12.0-16.0 g/dL), 1-5-year olds (11.4-14.1 g/dL) and infants (14.5-22.5 g/dL).

White blood cell counts were estimated microscopically in a counting chamber with a cover glass (haematocytometer) after diluting 20 µL of blood with 0.38 mL of diluting fluid (acetic acid-Gentian Violet). The count was done using the 10X objective and was reported as the number of white blood cells per litre of blood using a simple calculation (Cheesbrough, 1998).

Faeces examination was done to detect yeast cells microscopically after fixing a small amount of stool on a glass slide with a Bunsen flame. It was then visualized under a slide cover using a saline solution with the 40X objective (Cheesbrough, 1998).

Molecular analyses

DNA extraction

The Chelex method (Bio-Rad) was used to extract DNA for nested PCR from human blood that had been blotted as spots on filter paper and dried. A single blood spot from each filter paper was excised and then incubated for 4 h at room temperature or overnight at 4°C in 1 ml of 0.5% saponin in phosphate-buffered saline (PBS). The filter paper was washed for 30 min in PBS at 4°C and transferred into new tubes containing 50 µL of 5% Chelex-100 (Bio-Rad Laboratories, SIGMA) and the tubes were homogenised for 30 s. The mixture was incubated at 100°C for 15 min, homogenised for 30 s, heated again at 100°C for 15 min to elute the DNA, homogenised one more time, and then centrifuged (10,000 rpm for 2 min). The supernatant (DNA extract) was either used immediately for the reaction or stored in aliquots at 20°C.

Nested PCR for speciation

The species-specific nucleotide sequences of the 18S rRNA genes of *Plasmodium* were the targets of the experiment that was carried out as described by Snounou et al. (1993). The reaction conditions were according to the method of Boonma et al. (2007) with slight modifications as described subsequently.

In the first PCR, 2 µL of template DNA (corresponding to approximately 0.25 to 0.5 µl of blood) were added to a 18 µL PCR mixture that consisted of 10 µM each of universal primers (P1 forward primer [5'-TTAAAATTGTTGCAGTTAAAACG-3'] and P2 reverse primer [5'-CCTGTTGTTGC CTTAAACTTC-3']), 10 mM of each deoxynucleoside triphosphate, 15 mM $MgCl_2$ in 10X PCR Thermopol Buffer, and 5 U Taq DNA polymerase. DNA amplification was carried out under the following conditions: 95°C for 15 min, followed by 26 cycles at 94°C for 30 s, then 58°C for 1.5 min, and 72°C for 1 min, ending with a final hybridation and extension at 58°C, and 72°C respectively for 5 min. One microliter of this solution (Outer DNA product) was used in the second amplification in which it was added to 19 µL of master mix. This PCR was performed at 94°C for 10 min followed by 30 cycles at 92°C for 30 s, 60°C for 1.5 min, 72°C for 1 min, and ending with a final extension at 72°C for 5 min with the P1 forward primer in combination with each species-specific reverse primer (*P. falciparum f/r*, 5'TTAAACTGGGAAAACCAAATATATT/ACACAATGAACTCAATCATGACTA CCCGTC3'; *P. malariae f/r*, 5'ATAACATAGTTGTACGTTAAGAATAACCGC/AAAATTCCCATGCA TAAAAAATTATACAAA-3'; *P. ovale f/r*, 5' ATCTCTTTTGCTATTTTTTAGTATTGGAG/GGAAAAGGACACATTTGTATCCTAGTG-3'). The amplified products were visualized on 2% agarose gels stained with ethidium bromide. The expected band sizes were approximately 1200 bp for the first PCR products specific for the *Plasmodium* genus; and for the second one specific for species, 205 bp for *falciparum*, 144 bp for *malariae,* and 800 bp for *ovale*. To prevent cross-contamination, different sets of pipettes and distinct work areas were used for DNA template preparation, PCR mixture preparation, and DNA amplification.

Statistical analyses

The XLSTAT Windows version 13.0 was used both for data entry and analyses. Differences in clinical parameters were evaluated using a non-parametric (Mann-Whitney) test. Concordances between the RDT/MIC, RDT/PCR and MIC/PCR were evaluated using the Kappa Cohen coefficient test. The performances (sensitivity, specificity, positive predictive value and negative predictive value) of the tests were also determined, using standard formulae, to compare the diagnostic methods. Significant levels were fixed at 5%.

RESULTS

A total of 50 less-than-five-year-old patients were enrolled in the study, including 24 males (48%) and 26 females (52%). The median age was 27.5 months (CI: 18-48) and the mean body temperature was 38.8±0.72°C.

Table 1. Causes of febrile diseases in the study.

	Number of cases	Cases (%)
	Mono- and co-infection (n=50)	
Toxoplasmosis	11	22
Malaria	4	8
Typhoid fever	4	8
Malaria-typhoid fever	7	14
Malaria-toxoplasmosis	2	4
Malaria-toxoplasmosis-typhoid fever	3	6
Total toxoplasmosis	16	32
Total malaria	16	32
Total typhoid fever	14	28
Rubella	0	0
Undetermined	19	38

Table 2. Symptomatic presentation of children with infections.

Symptoms	Malaria	Toxoplasmosis	Typhoid Fever	Undetermined
	Positive n=16 (%)	Positive n=16 (%)	Positive n=14 (%)	n=19 (%)
Cough	11 (68.75)	11 (68.75)	10 (71.42)	19 (100)
Diarrhea	2 (12.25)	3 (18.75)	1 (7.14)	5 (26.31)
Asthenia	14 (87.5)	13 (81.25)	12(85.71)	16 (84.21)
Ear-nose-throat	5 (31.25)	11 (68.75)	6 (42.85)	7(36.84)
Skin rashes	0 (00.00)	4 (25)	0 (00.00)	7 (36.84)
Headaches	7 (43.75)	3 (18.75)	6 (46.85)	5 (26.31)
Respiratory distress	2 (12.25)	3 (18.75)	1 (7.14)	5 (26.31)
Stomach pain	5 (31.25)	5 (31.25)	3 (21.42)	1(5.2)
Vomiting	8 (50)	6 (37.5)	5 (35.71)	0(00)
Anorexia	10 (62.5)	7 (43.75)	8 (57.14)	9(47.36)
Chills	5 (31.25)	2 (12.25)	4 (28.57)	1(5.2)
Constipation	2 (12.25)	0 (00)	2 (14.28)	1(5.2)
Convulsion	1 (6.25)	1 (6.25)	0 (00.00)	0(00)

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Table 1 shows the causes of the febrile illnesses in the study population. Toxoplasmosis and malaria were the major causes of the fevers which in some cases presented as single, double and even triple infections. No case of rubella was detected and these RDTs for the four common causes of fever in the setting could not determine the cases of 19 children.

Table 2 depicts the burden of clinical symptoms that the febrile children presented with. They were found to be highly similar for the 3 diseases, with asthenia as the most noted, while erythema, constipation and convulsion were the least represented.

Table 3 indicates the biological parameters of the febrile children. With respect to these, glycaemia was not significantly different with or without malaria (p=0.6), toxoplasmosis (p=0.2), or typhoid fever (p=0.8).

However, children with malaria had significantly lower median total white blood cell counts (p=0.02), while a significantly lower median haemoglobin level was seen in children infected with toxoplasmosis (p=0.03).

Table 4 shows the relationships between possible sources of exposure to the 3 diseases. There was no significant impact of the factors on disease occurrence.

Figure 1 depicts Plasmodium species identified by nested PCR. Microscopy for malaria without speciation revealed that 14 (28%) were positive for the parasite while the rest of the 36 (72%) were negative and the parasite density ranged from 1000 to 270 000 parasites/µl of blood while the median was 43 474 parasites/µl of blood. From the 2 rounds of nested PCR, 19 (38%) turned out to be positive for malaria against 31 (62%) negative cases. Three species were differentiated: *Falciparum, malariae* and *ovale* in the mono- and mixed infections. *P. falciparum* was not the dominant species

Table 3. Biological parameters of the children with febrile diseases.

Parameter	Malaria		Toxoplasmosis		Typhoid fever	
	Mal+ (16)	Mal- (34)	Toxo+ (16)	Toxo- (34)	Typhi+ (14)	Typhi- (36)
Glycaemia (mg/dL)	109(91-142)	104 (97-120)	104 (91-115)	111 (97-139)	105 (90-141)	106 (95-127)
P values	(*p*=0.6)		(*p*=0.2)		(*p*=0.8)	
Haemoglobinemia (g/dL)	9.85 (7.9-11.25)	9.85 (8.9-11.1)	9.06 (8.9-10.7)	10.45 (9.75-11.35)	9.6 (9.4-10.7)	9.95 (8.95-11.15)
P values	(*p*=0.4)		(*p*=0.03)		(*p*=0.9)	
WBC x10^{9}cell/µl	4.95 (3.8-5.7)	6.65 (5-9.3)	6.65 (4.85-11.2)	5.5 (4.6-7.1)	5.7 (4.9-6.7)	6.15 (4.6-8.1)
P values	(*p*=0.02)		(*p*=0.2)		(*p*=0.7)	

Mal, Malaria; Toxo, Toxoplasmosis; Typhi, Typhoid fever; WBC, White Blood Cells; cell, cells. The results are presented in median (interquartile domain).

Table 4. Relationship between febrile illness and possible sources of exposure.

Parameter	Malaria		Toxoplasmosis		Typhoid	
	Mal+ (16)	Mal- (34)	Toxo+ (16)	Toxo- (34)	Typhi+ (14)	Typhi- (36)
Use of mosquito nets						
Yes	9	23	-	-	-	-
No	7	11	-	-	-	-
P value	*p*=0.434		-		-	
Contact with domestic animals						
Yes	-	-	8	11	-	-
No	-	-	8	23	-	-
P value			*p*=0.230		-	
Consumption of drinking water						
Yes	-	-	-	-	11	27
No	-	-	-	-	3	9
P value	-		-		*p*=0.8	
Cleanliness of habitat						
Yes	5	8	-	-	4	9
No	11	29	-	-	10	27
P value	*p*=0.6		-		*p*=0.796	
Consumption of vegetables/meats						
Yes	-	-	9	13	7	15
No	-	-	7	21	7	21
P value	-		*p*=0.231		*p*=0.6	

Mal+ , Cases of malaria; Mal- , cases without Malaria; Toxo+ , cases of toxoplasmosis; Toxo- , cases without toxoplasmosis; Typhi+ , Cases of typhoid fever; Typhi, cases without typhoid fever.

encountered (11/19, 57.86%) though slightly less than *malariae* (12/19, 63.15%) and more than *ovale* (7/19, 36.84%). The mixed *falciparum-malariae* infections represented 21.05% of the cases.

Of the 19 fever cases not diagnosed by any of the RDTs, 7 had yeast in their faeces, 9 had upper respiratory tract infections (URTI) and 3 were unspecified.

Table 5 shows the performances of RDT, microscopy and PCR for malaria. The malaria RDT showed a very good performance as compared to microscopy with a sensitivity of 92.9% DI [66.1-100] and a specificity of 91.7% DI [77.3-97.7]. Malaria RDT and PCR showed good performance when compared to microscopy which is the gold standard method for the detection of this disease.

DISCUSSION

Malaria is a frequent and preoccupying health issue in children in malaria-endemic areas. Because of the similarity of its symptoms with other common causes of

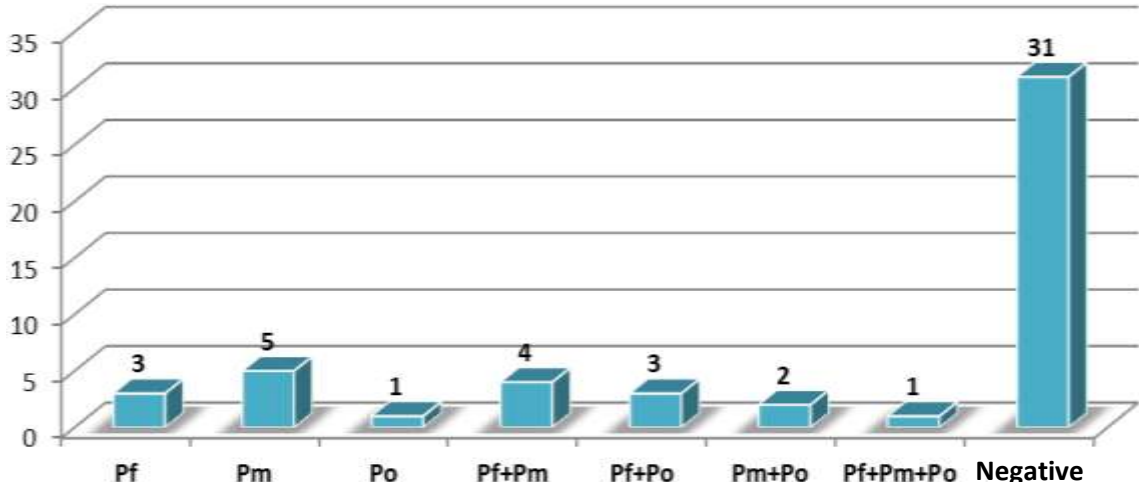

Figure 1. Malaria speciation by nested PCR.

Table 5. Sensitivity, specificity of nested PCR, microscopy and RDTs in the diagnosis of malaria in the study population.

Test	MIC				
	Sensitivity %	**Specificity %**	**PPV %**	**NPV %**	***k***
RDT	92.2(66.1-100)	91.7(77.3-100)	81.3(62.1-100)	97.1(91.7-100)	0.81(p<0.0001)
PCR	100(86.6-100)	73.7(50.8-88.4)	100(100-100)	86.1(74.8-97.4)	0.77(p<0.0001)

MIC, microscopy; RDTs, rapid diagnostic tests; PPV, positive predictive value; NPV, negative predictive value; 95% confidence intervals are indicated in parentheses.

fever, it is the most frequent culprit, and this results in failure to diagnose and treat other life-threatening conditions. The present study highlighted the causes of fever in children less than 5 years old in a health facility in Yaounde, Cameroon, a country in sub-Saharan Africa where approximately 95% of the malaria cases are due to *P. falciparum*. RDTs made it possible to detect that the fevers were related to malaria, toxoplasmosis and typhoid, with no case of rubella. Microscopy and PCR methods were strongly in agreement with the RDT results for malaria. A preceding study in Burkina Faso during the rainy season, using RDTs, showed that almost half of all the fevers were due to malaria and this proportion was very high among the children and infants (Wang et al., 2005). Our study, undertaken during the rainy season (March-April) as well, on the contrary showed a lower frequency of malaria in less than half (1/3) of the children. These results however corroborated with the 29% (1/3) of malaria cases found among febrile patients by Mangham et al. (2012) in Cameroon. They equally found 70% (2/3) with negative results for whom an antimalarial had been prescribed or administered, pointing to the overdiagnosis and wrong treatment of the condition, and thereby overlooking the real causes of the fevers. This supports the fact that even in high malaria transmission zones, fever in children less than 5 years is not exclusively due to malaria and malaria case management has to be improved since symptomatic diagnosis is inefficient because two-thirds of febrile patients may be found not to have malaria.

The cases of fever in our study were due to mono- and co-infections. The co-infections could explain the persistence of the condition due to the poor or insufficient diagnosis. The number of children with fever due to toxoplasmosis mono-infection was a call for more attention to be paid to this disease which is not often included in the differential diagnosis of fever (Asad et al., 2006). The present study found that toxoplasmosis cases were higher in number than malaria and typhoid fevers. Sayang et al. (2009) had also shown that malaria was not the first cause of fevers in children less than 5 years old in Yaounde. The observation of the absence of rubella could be an indication that the anti-rubella vaccine administered to pregnant women and the resulting transplacental passive immunisation of their unborn children is very effective. The symptoms of malaria, toxoplasmosis and typhoid fever were very similar, indicating the difficulty in discriminating malaria from the others on a simply clinical basis. This again exacerbates the limits of presumptive diagnosis in the management of these diseases. Indeed, Hogh et al. (1995) had shown that the clinical diagnosis of malaria, especially in infants,

has a poor accuracy and a low positive predictive value because its symptoms and signs are variable and can easily be mimicked by other infectious or non-infectious diseases.

Malaria was associated with a significant drop in the level of white blood cells, which could be explained by the fact that during the illness they relocalise from the members (where blood is generally drawn for the tests) to the spleen and other such affected internal organs where they actively get involved in the fight (McKenzie et al., 2005).Toxoplasmosis was associated with a drop in the level of red blood cells. This can be explained by the fact that the parasite infects these cells, resulting in anaemia which is a critical manifestation of the disease (Michelson and Lammi, 1984). The presence of yeast in the stool of some of the patients could explain the cause of their fever that was not detected by the RDTs. The 57.86% frequency of *P. falciparum* obtained was higher than the 12% reported in Tanzania (Mazigo et al., 2011), close to the 56.9% reported in a similar study in Nigeria (Ikeh and Teclaire, 2008) and the 72.86% found in Cameroon (Achonduh et al., 2013), and lower than the 96.5% reported in another similar study in Nigeria (Bousema et al., 2008). Moreover, Bousema et al. (2008) reported that a mixed *P. falciparum/P. malariae* infection could have an implication on the transmission of *P. falciparum* since *P. malariae* seems to increase the gametocytes of *P. falciparum* (Swartout et al., 2007).

Few studies have been carried out specifically on the use of RDTs in the case management of sick African children less than 5 years old in areas of intense malaria transmission (Tarimo et al., 2001; Rimon et al., 2003). The statistical kappa test showed a very good significant association between RDT/MIC (0.81, p<0.0001) and RDT/PCR (0.84, p<0.0001) and a good significant agreement between PCR/MIC (0.77, p<0.0001). This suggests that the RDT is a good and simple tool for the diagnosis and confirmation of malaria cases for management of febrile illnesses in children (Faucher et al., 2010). It can therefore be implemented in the Integrated Management of Childhood Diseases program (Tarimo et al., 2001), allowing for a rationalized management of children with fevers (Sayang et al., 2009; Msellem et al., 2009). To be able to institute clinical management, other structures would have to be put in place to improve on health delivery services that would help in lowering unnecessary expenditures.

An indirect advantage of the malaria RDT is that it draws quick attention to the non-malarial infections in the event of negative results (Sayang et al., 2009; Swartout et al., 2007) but the disadvantage is that this latter event can easily increase the use of antibiotics, promoting resistance.

The small sample size of the population stands as a limit to sustain the conclusions arrived at, though the hypothesis initially set was confirmed by this pilot study. Nevertheless, the results presented show that RDTs are reliable in peripheral settings where microscopy or PCR are not available. Therefore, there is a need for an epidemiological study to be conducted on the other causes of fever over the national territory where the epidemiology of malaria is not uniform. In this way, a follow-up algorithm can be proposed for patients with fever based on biological diagnosis.

Conclusion

Malaria was not the exclusive cause of fever in the population of children studied. Toxoplasmosis occurred in proportions similar to malaria (32%). Typhoid fever was the third most common infection, affecting 28% of the patients. RDTs were shown to be good diagnostic tools that can be used for the appropriate diagnosis and management of childhood malaria and other illnesses which have fever as the major aetiology.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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Full Length Research Paper

Death certificates errors in academic hospital; Review of 617 cases at Komfo Anokye Teaching Hospital (KATH), Kumasi

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The importance of death certification goes beyond the benefits to the health facility as they also provide invaluable legal and epidemiological benefits. Errors in filling Medical Certificates of Cause of Death (MCCD) greatly affect global mortality statistics and hence create challenges for public health programs to be executed effectively. The present study used both retrospective and prospective study design to review 617 death certificates. Male mortality rate was prevalent, accounting for 54.0% (p=0.033), modal age range was from 40 to 59 years (p=0.000), while most certificates were issued in January (p=0.000). Most death cases and errors were from the medicine specialty with Bachelor of Medicine, Bachelor of Surgery/Chirurgery (MBCHB) qualification. Single, double and multiple errors were recorded in the present study. Absence of time interval of cause of death, incomplete cause of death and abbreviations were the prevailing errors. Others include absence of physician qualification and department/ward, handwriting and cause of death queries (p=0.000). Errors can be reduced by organizing periodic seminar on death certification for clinicians, especially trainees/interns.

Key words: Death certification, errors, benefits, clinician.

INTRODUCTION

The importance of death certification goes beyond the benefits to the health facility as they also provide invaluable legal and epidemiological benefits. The emergence of public health programs is highly influenced by mortality statistics obtained from death certification (Pritt et al., 2005; Myers and Farquhar, 1998).

Errors in filling Medical Certificates of Cause of Death (MCCD) greatly affect global mortality statistics and hence create challenges for public health programs to be executed effectively. Studies conducted in South America (Antini et al., 2015), Asia (Haghighi et al., 2014) and Africa (Izegbu et al., 2006) have confirmed high incidence of inaccuracies in death certification. Contrarily, some measures have been put in place over the years to ensure accurate death certification in many countries such as USA, Scotland, Finland and Sweden (Lahti and

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Penttilä, 2001; Cameron and McGoogan, 1981; Johansson and Westerling, 2000; Kelson and Farebrother, 1987).

Cause of death must provide information on the mechanism and the underlying conditions leading to demise of subject. These must be properly sequenced without any competing cause. Incomplete filling or improper sequencing of cause of death are regarded as a major error. Hence, it must be written without ambiguity or query (Azim et al., 2014). Minor errors on the other hand refers to the use of symbols, abbreviations, absence of deceased and physician information, time interval and illegible handwriting (Filippatos et al., 2016; Azim et al., 2014; National Center for Health Statistics, 2003).

A major factor for the high inaccuracies in determining the cause of death is lack of formal training of interns, residents and medical officers in filling death certificates (Messite and Stellman, 1996; Sehdev and Hutchins, 2001). This study seeks to identify the various certification errors by clinicians at teaching hospital.

MATERIALS AND METHODS

This study used both retrospective and prospective study design to review all the death certificates received at the Department of Pathology- KATH (Kumasi-Ghana) from August, 2015 to July, 2016. Retrospective review was adopted to retrieve certificates from archives from August to December, 2015. All the 2016 files were recorded daily as they are received at the department.

A total of 617 MCCD were reviewed; 293 in 2015 and 324 in 2016. Details of deceased recorded from certificates include sex, age and date of death. Clinician information includes qualification and ward/department address.

The major errors identified for the present study were related to cause of death and it includes incomplete filling of cause of death and queries. The minor errors of certification were absence of ward/department address and physician qualification, abbreviations and illegible handwriting. Multiple errors were recorded from some certificates. All the certificates issued within the period of study were included in present study since anomalies in certificate are being considered. Accuracy of cause of death were not considered for this study due to absence of independent reviewer of certificates from the health facility. Time interval of cause of death was excluded since it was absent in almost all the certificates issued.

Data was transferred and grouped on excel spreadsheet according to the month of issue. Data analysis was carried using IBM Statistical Product for Social Sciences (SPSS) software version 20 with confidence level of 95% (α=0.05).

RESULTS

All MCCD received within the period were recruited in this study. Statistical significant figures were obtained for age and sex distribution. Male mortality rate was prevalent accounting for 54.0%, while that of females was 46.0%. Majority of the deceased were within the age range of 40 to 59 years. This was marginally trailed by the age ranges of 60 to 79 and 20 to 39 years. Mortality rate of aged (80 years and above) was higher than that of children (below 1 year old), while those from 1 to 19 years had higher prevalence than both. Data on ages of 7 deceased were unknown (Table 1).

A significant month and year distribution showed a modal certification in January while June recorded the least. The lead was closely followed by October, February and December (Table 2).

Medicine issued the highest number of MCCD (57.1%); designated either emergency medicine, internal medicine or medicine. This was followed by surgery (11.3%), pediatrics (9.7%), obstetrics and gynecology (O&G) (5.7%) and intensive care unit (ICU) (2.4%). Accident and emergency (A&E), and Anesthesia had equal number of MCCD (1.8% each) while ear, nose and throat (ENT), pathology, radiology and oral health had less than 10 MCCD each. Oncology had the least certificates (0.2%), while 0.5% MCCD were received from satellite hospitals. Department or wards were not provided on 47 certificates (Table 3).

The peak qualifications of medical practitioners as seen on MCCD were MBCHB accounting for 70.8%. Physicians who are either specialist or senior specialist constituted 12.3%, consultants were 3.2%, resident doctors and medical officers were 2.8 and 0.8%, respectively. Physician assistants and Bachelor of dental surgery (BDS) also accounted for 0.2 and 0.3%. Certificates with missing physician qualifications accounted for 9.6% (Table 4).

Statistical relevant values were obtained in the study showing 378 certificates were without major or minor errors (excluding time interval). One hundred and twenty-eight certificates had incomplete filling of cause of death, while 2 certificates showed completely filled cause of death with queries. Abbreviation of medical conditions was observed on 33 certificates, while handwritings on 5 certificates were not legible. Absence of physician qualification and department/ward details were identified on 39 and 8 certificates, respectively. The remaining certificates had multiple errors. Only 3.7% of all the certificates had time interval written for cause of death.

Most errors were found to stem from medicine, while the least was from oncology. Surgery, pediatrics and O&G recorded appreciable number of certificates with errors. Certificates from pathology, ENT and satellite hospitals recorded null certification errors (Table 3). The peak qualification with errors was MBCHB, followed by specialist and consultant. Few errors were associated with medical officers and dentists (Table 4).

DISCUSSION

Accurate death certification is paramount to public health surveillance in every country. Its importance goes beyond medical significance as it provides statistical mortality rate demographics of age, sex and the cause of death within a population. It also provides data for research and also aids in proper planning and execution of preventive

Table 1. Age and sex distribution of the deceased.

Age	Sex		Total (%)	p-value
	Male (%)	Female (%)		
Below 1	23 (3.7)	16 (2.6)	39 (6.3)	0.033
1 to 19	35 (5.7)	38 (6.2)	73 (11.8)	
20 to 39	58 (9.4)	57 (9.2)	115 (18.6)	
40 to 59	117 (19.0)	74 (12.0)	191 (31.0)	
60 to 79	78 (12.6)	61 (9.9)	139 (22.5)	
80 and Above	19 (3.1)	34 (5.5)	53 (8.6)	
Unknown	3 (0.5)	4 (0.6)	7 (1.1)	
Total	333 (54.0%)	284 (46.0%)	617 (100.0)	

Table 2. Monthly distribution of certification in 2015 and 2016.

Month	Year		%	p-value
	2015	2016		
August	10		1.6	0.000
September	44		7.1	
October	99		16.0	
November	57		9.2	
December	83		13.5	
January		101	16.4	
February		92	14.9	
March		57	9.2	
April		26	4.2	
May		18	2.9	
June		9	1.5	
July		21	3.4	
Total	293 (47.5%)	324 (52.5%)	617 (100.0)	

measures for health issues (Pritt et al., 2005). It is therefore cardinal for physicians to be veracious during certification.

Demographics of sex mortality rates in this study is in concordance with Filippatos et al. (2016) and Haghighi et al. (2014). Both studies documented high male mortality rate than females. Filippatos et al. (2016) had 50.7% male prevalence, slightly below that of this study. Haghighi et al. (2014) recorded 62.6% male prevalence which is above that of this study. However, Antini et al. (2015) and Nojilana et al. (2009) recorded 59.2 and 51% female prevalence, respectively, which is antipodal to findings of the present study.

Age demographics by different studies have documented disparate findings. This is primarily influenced by culture, genetics, nutrition and other environmental factors in ensuring quality and healthy lifestyle. Bowen et al. (1998) evidenced higher mortality rate among children below 1 year than those from 1 to 10 years. Findings of this study is polar to this findings. Filippatos et al. (2016) had a peak mortality among those above 80 years, while that of this study was from 40 to 59 years. Some studies recorded peak mortality from 60 years and above (Katsakiori et al., 2007). Average life expectancy of Ghanaians according to 2015 WHO report is 62.4 years (61 for males and 63.9 for females) (www.who.int). The modal age range mortality of present study is slightly below the estimated life expectancy.

Medicine issued the highest number of certificates than any other specialty or departments. This is similar to findings of most research on death certification. Some studies recorded most death cases at the Intensive Care Unit whiles others recorded most death cases at obstetrics and gynaecology (Izegbu et al., 2006; Madboly and Metwally, 2014).

Death certification is assigned to attending physician who has been with deceased within a period 14 days. However, it must be noted that this delicate responsibility is to be carried out by qualified and registered medical practitioners (National Center for Health Statistics, 2003). Unlike other medical facilities, teaching hospitals have the luxury of medical practitioners than the district and

Table 3. Distribution of major, minor and multiple errors among the various departments/wards.

Departments	Major errors			Minor errors				Multiple errors	Total	p-value
	Complete	Query	Incomplete	Abbreviation	No Qualification	No Ward Address	Handwriting			
Medicine	225 (36.5)		74 (13.1)	19 (3.1)	20 (3.2)		4 (0.6)	10 (1.6)	352 (57.1)	
Surgery	41 (6.6)	2 (0.3)	13 (2.1)	7 (1.1)	5 (0.8)			2 (0.3)	70 (11.3)	
Pediatrics	39 (6.3)		11 (1.9)		8 (1.3)			2 (0.3)	60 (9.7)	
O&G	18 (2.9)		8 (1.4)	4 (0.6)	3 (0.5)			2 (0.3)	35 (5.7)	
ICU	11 (1.8)		2 (0.3)		1 (0.2)			1 (0.2)	15 (2.4)	
A&E	6 (1.0)		4 (0.7)	1 (0.2)					11 (1.8)	
Anesthesia	7 (1.1)		2 (0.3)		2 (0.3)				11 (1.8)	
ENT	3(0.5)								3 (0.5)	
Pathology	3 (0.5)								3 (0.5)	0.000
Radiology	1 (0.2)		2 (0.3)						3 (0.5)	
Oral Health	1 (0.2)		2 (0.3)						3 (0.5)	
Satellite Hospital	3 (0.5)								3 (0.5)	
Oncology			1 (0.2)						1 (0.2)	
Unknown	20 (3.2)		9 (1.5)	2 (0.3)		8 (1.3)	1 (0.2)	7 (1.1)	47 (7.6)	
Total	378 (61.3)	2 (0.3)	128 (20.7)	33 (5.3)	39 (6.3)	8 (1.3)	5 (0.8)	24 (3.8)	617 (100.0)	

Complete = Without major or minor errors (without time interval); Incomplete = missing information on cause of death; Query = cause of death with question marks (?); No qualification = absence of physician qualification; No ward address = absence of ward/department of physician; Multiple Errors = more than 1 major, minor or both errors.

regional hospitals in Ghana. Graduate and undergraduate medical students are giving the opportunity to acquire practical knowledge during internships. Hence patients are usually assigned to team of doctors with different qualifications. For accuracy and precision sake, death certification must be done by the attending physician with the highest qualification and training in certification (Azim et al., 2014). MBCHB is the basic qualification of every medical practitioner and hence it is likely that some may not have adequate training in death certification (Izegbu et al., 2006; Myers and Farquhar, 1998). This account for the high number of errors committed by this group of medical practitioners. Furthermore, some studies have questioned the eligibility of house officers, residents, physician assistants and other trainees in death certification. These interns are temporal workers at health facilities and are likely to spend less time with patients in most cases (Maharjan et al., 2015). Studies conducted in Greece recorded more specialist and consultants than interns (Filippatos et al., 2016).

The present study documented 96.3% inaccuracy in recording time interval of cause of death. This is unacceptable as it questions the efforts of physicians in management of cause of death. Some studies recorded almost 100% absence of time intervals between causes (Filippatos et al., 2016; Nolijana et al., 2009). Myers and Farquhar (1998) recorded 71.6% omission of time interval during certification. Unlike Ghana, countries like Scotland and South Africa can boast of accurate death records certification by implementing effective quality assurance of death certificates. Advanced medical settings have independent medical reviewers who ensure accuracy in certification by physicians especially in the cause of death. KATH presently have no quality assurance mechanism to ensure high accuracy of death certification. Incomplete cause of death was the only major error considered in the present study. This was due to the absence of independent reviewer and also to avoid suspicion of partiality.

More than half of the certificates were filled without errors considered in the present study. This is expected since most physicians are educated on death certification during their medical training at the teaching hospital. Studies at academic hospital in South Africa recorded a lower number error-free certification (Nolijana et al., 2009). Certificates with only one minor error constituted 7.4%; include abbreviations, handwritings and absence of physician information while multiple errors constituted 4.0%. Absence of physician qualification was the prominent minor error in the present study. Madboly and Metwally (2014) recorded 3.5, 74.3 and 22.2% for single,

Table 4. Distribution of major, minor and multiple errors with qualification of physicians.

Qualification	Complete	Major errors (%)		Minor errors (%)					Total	p-value
		Query	Incomplete	Abbreviation	No qualification	No ward address	Handwriting	Multiple errors		
MBCHB	287 (46.5)		102 (16.5)	29 (4.7)		5 (0.8)	5 (0.8)	9 (1.5)	437 (70.8)	
Snr Specialist	60 (9.7)	1 (0.2)	13 (2.1)	1 (0.2)				1 (0.2)	76 (12.3)	
Consultant	13 (2.1)		4 (0.6)	2 (0.3)		1 (0.2)			20 (3.2)	
Resident	11 (1.8)	1 (0.2)	3 (0.5)	1 (0.2)		1 (0.2)			17 (2.8)	
Medical officer	4 (0.6)		1 (0.2)						5 (0.8)	0.000
BDS			1 (0.2)			1 (0.2)			2 (0.3)	
Physician assistant	1 (0.2)								1 (0.2)	
Unknown	2 (0.3)		4 (0.6)		39 (6.3)			14 (0.5)	59 (9.6)	
Total	378 (61.3)	2(0.3)	128 (22.3)	33 (5.3)	39 (6.3)	8 (1.3)	5 (0.8)	24 (2.2)	617 (100.0)	

double and multiple errors, respectively. Major errors were recorded among 22.6% certificates and this included incomplete filling and querying of cause of death. Most major errors were due to incomplete cause of death. This is consistent with findings of Antini et al. (2015).

Death certificates are used by clinicians, administrators, planners, epidemiologist and researchers. Accuracy is thus a prime consideration during certification. Clinicians may be acquainted with most medical terms or abbreviations and thus may be employed in certification. It must be noted that mortality records are mostly handled by people who are not familiar with medical clichés. Medical practitioners are advised to employ legible handwriting in certification. Medical symbols such as Rx, Tx, Dx, ?, etc, must be avoided. Abbreviation of medical conditions is not acceptable as this can lead ambiguity and delay in registration process. Cause of death must be accurate, precise, complete and sequentially filled. Each cause of death must also be reported with the appropriate time interval during certification. Details of physician such as name and qualification must always be properly and legibly provided to eradicate death certification errors (National Center for Health Statistics, 2003; www.sehd.scot.nhs.uk).

Limitation of study

This study did not consider other major errors such us improper sequencing of cause of death and hence further study is recommended to completely ascertain death certificates. It was also limited to one hospital and therefore more research must be conducted nationwide to aid having accurate database. Finally, information on mortality rate in Ghana is dearth and therefore calls for studies in this field.

Conclusion

The study has shown the flaw in death certification at teaching hospital. The incidence rate of inaccuracies in death certification is quite alarming. Furthermore, most of these are major errors which are mainly incomplete filling of cause of death. Majority of the errors were by physicians at their early stage of practice, primarily from the medicine unit. This can be rectified by adequate training of young physician on death certification as seen in other parts of the world. Independent reviewers can be employed to ensure proper death certification. This must be extended to other hospitals to ensure proper mortality statistics database in Ghana.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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