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## MANAGEMENT OF ANTIMALARIAL DRUGS IN THE URBAN PUBLIC HEALTH FACILITIES IN TANZANIA

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### Keywords:

Pharmaceutical management, Health facilities, Antimalarial drugs, Artemether-lumefantrine

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**ABSTRACT:** Frequent drug shortage, poor storage conditions and inadequate knowledge of health care workers for inventory management are among the factors affecting the supply chain of antimalarial drugs in Tanzania. These factors largely contribute to poor quality, shortage and irrational use of antimalarial drugs in the public health facilities. The aim of this study was to assess the management of antimalarial drugs in the public health facilities in Dar-es-salaam, Tanzania. Thirty two (32) pharmaceutical personnel were interviewed regarding management of antimalarial drugs in the health facilities. The average time stock-out of antimalarial drugs was assessed for the period of January to December 2010. Adequate storage conditions and handling of medicines procedures were also assessed. About two thirds of drug store managers had poor knowledge on quantification concept. All drug store managers had inadequate knowledge on the concept of procurement, and there were no effective and efficient procurement systems in all the health facilities. The percentage time for stock-out of antimalarial drugs was 25% for Artemether-Lumefantrine (ALu), 25.7% for quinine tablets and 6.4% for quinine injections. All facilities had no cold storage facilities with temperature charts, and medicines were kept directly on the floor in most of the health facilities. Frequent stock-outs of ALu in the public health facilities is mainly due to poor pharmaceutical management of antimalarial medicines in these facilities. Provision of regular on-job training and continuing education among pharmaceutical personnel in the public health facilities is necessary to address this problem.

**INTRODUCTION:** In response to the World Health Organization (WHO) recommendations to change malaria treatment policies from monotherapy to artemisinin combination therapies (ACT) <sup>1</sup>, Tanzania replaced sulfadoxine-pyrimethamine with artemether-lumefantrine (ALu) as the first line antimalarial drug for treatment of uncomplicated malaria <sup>2</sup>. By 2007, ALu was available in more than 75% of the public health facilities in Tanzania <sup>3</sup>.

The availability of ALu in the private retail pharmacies was about 50% during that time. In 2010 ALu was available in 87% of the private retail pharmacies in Dar es Salaam <sup>4</sup>, an indication that the drug is increasingly available both in the public and private health facilities in Tanzania.

Antimalarial drugs especially artemisinin combination therapies such as ALu could be costly and unaffordable to most people in developing countries like Tanzania. However, in Tanzania the price of ALu has been subsidized to increase its accessibility in terms of its affordability to most people. For instance, in 2008 the adult dose of ALu (branded as Coartem®) was sold at about \$10 in the retail private pharmacies. Currently, the drug is sold at \$0.625 <sup>5</sup>. Although the price of ALu has

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been subsidized to increase affordability, there are still other factors that may affect its availability and rational use.

Pharmaceutical management is the set of practices aimed at ensuring timely availability and appropriate use of safe, effective, and quality medicines and related products and services in any health-care setting. It has four components that form a cycle, namely selection of the product, procurement, distribution and its use to the patients<sup>6</sup>. Therefore proper pharmaceutical management ensures availability and rational use of antimalarial and other drugs in patients.

The main challenge in pharmaceutical management in Tanzania is a severe shortage of qualified human resources for health<sup>7</sup>. Most health care workers who are involved in pharmaceutical management are not trained pharmaceutical personnel<sup>8</sup>. As a result, pharmaceutical management including ordering of drugs, storage and inventory control are not properly done. This could be one of the reasons for frequent stock-outs of essential medicines in the health facilities in Tanzania<sup>6</sup>.

Inventory management refers to the process of managing inventory in order to meet patient demand at the lowest possible cost with minimum of investment. Unlike many factors in pharmacy, inventory is controllable, and the pharmacy department normally decides how much inventory investment to make, when to reorder, and in what quantities<sup>9</sup>. Accurate and current stock records are essential to good inventory management.

They are the sources of information used to calculate the needs, and inaccurate records produce inaccurate estimations, leading to stock outs and expiry of medicines<sup>10</sup>. Therefore good pharmaceutical management of antimalarial drugs and other essential medicines is necessary in reducing the cost of purchasing medicines, both at the national and health facility levels.

Apart from ensuring constant availability of antimalarial and other medicines, pharmaceutical management also focuses on the quality of pharmaceutical products<sup>6</sup>. In this aspect, quality control extends beyond testing whether medicinal products contain the right ingredients in the correct

amount, to ensuring that they are properly stored and have not passed the expiry date. The latter measure is intended to ensure that, at the final distribution point, patients are getting high quality and efficacious drugs<sup>11</sup>.

Countries with tropical climates such as Tanzania can experience difficulty in maintaining good drug storage conditions. Prevailing conditions of high temperature and humidity; common storage problems, such as storage on the floor; lack of systematic arrangement of stock; presence of dust and pests; inadequate protection from direct sunlight; and lack of provision of temperature monitoring charts and facilities to monitor room temperature can lead to degradation of medicines<sup>11</sup>.

Lack of efficient and effective procurement methods of pharmaceuticals in the health facilities may also lead to poor availability of medicines in the health facilities. Patients will miss or get inadequate amount of the prescribed medicines required for their treatment. Poor availability of medicines may promote irrational use of medicines by promoting prescribers to prescribe medicines that are only available. In addition, poor adherence to standard treatment guidelines (STGs) for management of malaria is another area that commonly occurs in most of the health facilities in Tanzania<sup>12</sup>. Failure to adhere to STGs may also produce wrong consumption data of medicines that may affect the process of good forecasting and quantification, leading to under- or over-stocking of medicines in the health facilities.

In Tanzania, the level of knowledge and practice of pharmaceutical management among health care workers in the public health facilities is not documented. It is also not well documented if health care workers who are involved in pharmaceutical management of antimalarial drugs in the public health facilities are well trained to effectively carry out their duties. Availability and use of STGs for antimalarial drugs in these facilities need also to be assessed.

The main focus of this study was therefore to assess the pharmaceutical management of antimalarial drugs in the public health facilities in the urban area in Tanzania.

## **METHODOLOGY:**

### **Study Design**

A descriptive retrospective cross-sectional design was used to conduct this study. Questionnaires were used to interview drug store managers and dispensers regarding pharmaceutical management of antimalarial drugs in the facilities. Stock-out data form and other forms were designed and used to collect data from drug registers and storage conditions in the selected health facilities.

### **Study Sites**

The study was conducted from January to April 2011 in Dar es Salaam, the commercial capital of Tanzania. Administratively, Dar es Salaam is divided into 3 municipalities namely Ilala, Kinondoni, and Temeke. This study was conducted in all the municipal public hospitals and health centers that are in Kinondoni, Ilala and Temeke municipalities. There are two hospitals and one health centre in Temeke municipality; Ilala municipality has one hospital and two health centers; and Kinondoni municipality has one hospital and two (2) health centers. Since the Medical Stores Department (MSD) is the main supplier of antimalarial drugs in these facilities, it was included in this study as the special study site for assessing availability, and quality of the drugs from the source. Therefore a total of nine (9) health facilities and MSD were used to assess pharmaceutical management of antimalarial drugs in the urban setting in Tanzania.

### **Study participants**

Because of the small numbers of the pharmaceutical personnel in the public health facilities in Tanzania<sup>13</sup>, a convenient sampling technique was used to get the study sample size. Therefore this study involved all pharmaceutical health workers that were available during the study survey in all of the selected health facilities. These included pharmacists/drug store managers, and other drug dispensers who were available in the selected health facility during the time of the study. A total of 32 pharmaceutical personnel were interviewed.

### **Data Collection**

Questionnaires were used to interview drug store managers and drug dispensers. These questionnaires contained information and questions

designed to identify the influencing factors associated with supply chain of antimalarial drugs. Questions were designed to assess the knowledge of the drug store managers (pharmacists, pharmaceutical technicians or pharmaceutical assistants) on pharmaceutical management of antimalarial drugs.

Other questions were designed to assess the knowledge of pharmaceutical personnel regarding quantification and methods of inventory management; management of expired antimalarial medicines; and sources of medicines (i.e. suppliers). A knowledge scale was developed in which a zero (0) point was given for an incorrect answer and one (1) point was given for the correct answer. Then the levels of knowledge were graded as Excellent (75-100%), Good (50-74%), Poor (25-49%) and Very poor (0-24%).

### **Assessment of stock-out of antimalarial drugs**

Stock-out data forms were designed to collect data on the number of days during which antimalarial drugs were out of stock in the main drug store at the health facilities and MSD. The number of stock-out days was recorded for the period of January to December 2010. This period of one year was purposely considered in order to reduce confounding factors of seasonal variation<sup>11</sup>.

### **Assessment of adequacy storage conditions and handling of medicines**

A checklist was used to assess storage conditions and handling of medicines in the health facilities. Using WHO indicators<sup>11</sup>, nine questions were adopted in the checklist, and the average score was calculated from each column results (i.e. from drug store and dispensing room). Levels of storage conditions and handling of antimalarial drugs in the health facilities were graded as very satisfactory (75–100%), satisfactory (50–74%), dissatisfactory (25-49%) and very dissatisfactory (0-24%).

### **Data Management and Analysis**

Data were analyzed using Statistical Package for Social Sciences (Version 16.0) computer analysis software. Measure of the central tendency and dispersion were analyzed and reported by using descriptive statistics. Fischer Exact Test was used to calculate p-values which were then utilized for

measuring the significance of differences for the study variables.

A p-value of less than 0.05 was considered statistically significance at the 95% confidence interval. Study variables that were considered for the purpose of this study were demographic data of the pharmaceutical health workers, knowledge in practice of pharmaceutical personnel regarding antimalarial drug management, percentage average time for stock-out of ALu and other antimalarial medicines, knowledge of pharmaceutical personnel regarding inventory management methods, awareness of pharmaceutical drug store managers on disposal system of expired medicines, adherence to the National Malaria Treatment Guidelines and challenges for the implementation of the Malaria Treatment Guidelines at the facility level.

### **Ethical Consideration**

Study participants were informed about the purposes of the study. Written consent was then obtained from the study participants. No names of study participants were recorded in the questionnaires and data were entered into the computer for analysis using code numbers assigned to each questionnaire.

Ethical clearance was obtained from Muhimbili University of Health and Allied Sciences Research and Publications Committee. Permission to conduct the study in the selected health facilities was sought from the Municipal Medical Officers in-charge.

## **RESULTS**

### **Knowledge in practice of pharmaceutical health workers on antimalarial drug management**

#### **Quantification and Forecasting**

Among the 9 drug store managers, 5 of them had no general concept of the quantification process of the medicines including antimalarial drugs. Out of 4 drug store managers (pharmacists), only 3 had general concept of quantification process; and 5 of all respondents (pharmaceutical technicians), only 1 provided the correct information about quantification concept. Also among those who indicated that they have general concept of the quantification process of medicines, two of them did not know the advantages of effective and

efficient quantification process of medicines in the health facility system. These results have shown that there is significant association of quantification knowledge and qualification levels of pharmaceutical professionals ( $P < 0.05$ ).

Among all the interviewed drug store managers who are pharmacists, 3 had satisfactory knowledge about the use of ILS while the rest had poor knowledge in this aspect. All the drug store managers who are pharmacist indicated that ILS does not help to get good estimation of drugs to be purchased, while 4 of them mentioned that ILS is difficult to use.

One pharmaceutical technician had satisfactory knowledge on ILS, and three others indicated that the system is confusing to be effectively utilized. Assessment of the association between perceptions on the ILS with the professional of store managers indicated a significant variation of ILS application among the qualification levels of pharmaceutical professionals ( $\chi^2 = 6.975$ ,  $df = 2$  and  $P < 0.05$ ).

### **Procurement and inventory management**

Out of the 9 visited health facilities, 7 of them procured antimalarial medicines from MSD only, while the remaining 2 health facilities were procuring antimalarial medicines from both MSD and private sources including wholesale pharmacies and medicine supplying agents in Tanzania.

Even though most of the visited health facilities indicated that they obtained antimalarial medicines, especially ALu from the MSD alone, the study findings show that other antimalarial medicines such as artemether injections, dihydroartemisinin-piperaquine (Duo-cotecxin<sup>®</sup>; Holley Pharmaceuticals, Tustin, CA, USA) and quinine injections were received as donations from medical agencies through the Ministry of Health and Social Welfare. Good examples were Mwananyamala and Amana municipal hospitals which had larger amounts of donated artemether injections and other antimalarial medicines in the stock.

This study also assessed the existence of the procurement units in which drug store managers are supposed to be members of the unit for pharmaceutical profession assistance. Results

obtained from the survey indicate that all the public health facilities surveyed had no such procurement management units.

The results also show that all the interviewed pharmaceutical personnel did not know the concept of procurement period used in their health facilities. For instance, regarding the lead time concept, 6 drug store managers revealed that their lead time period was less than one month; the other 3 indicated that the lead time at their health facilities was between 1 to 2 months.

With regard to record keeping in the health facilities, only 2 of the visited main drug stores were using BIN card systems, while 7 facilities were using stock ledger books as their means of inventory control systems. Mwanayamala Hospital was using both BIN card and stock ledger systems. No health facility was found to be using electronic drug record systems. Each public health facility had different numbers of dispensing sections, with the mean number of 2 dispensing sections. This meant that one main drug store was supplying medicines and medical devices to at least two dispensing rooms or satellite pharmacies within the health facility.

Study findings also revealed that for application of stock flow approach among the nine drug store managers, only one manager was using First-In First-Out (FIFO) system of supplying antimalarial and others medicines. Five managers were using First-Expiry First-Out (FEFO) system, and three managers were using both FIFO and FEFO. Assessment of the association between applications of stock flow approach with the professional qualifications of the drug store managers indicated no significant difference between pharmacist and pharmaceutical technicians ( $P = 0.151$ ).

### **Disposal of the expired antimalarial drugs and others medicines**

It was pointed out in 7 of the visited public health facilities that expiry of medicines was a very common problem in their main drug stores. Reasons given for expiration of medicines were; donations of drugs with short shelf lives from donors, private medical companies and other medical agencies. Other reasons were over stocking of medicines due to poor estimations of quantities

to be purchased or procured, influence of the patients to choose branded medicines over generics, and hence most of the generic medicines were not fast moving. In these facilities, expired drugs had not been disposed for more than six years. The main reason given for not disposing expired drugs was the long, bureaucratic and tedious process for drug disposal.

### **Average stock-out days for antimalarial drugs in the health facilities**

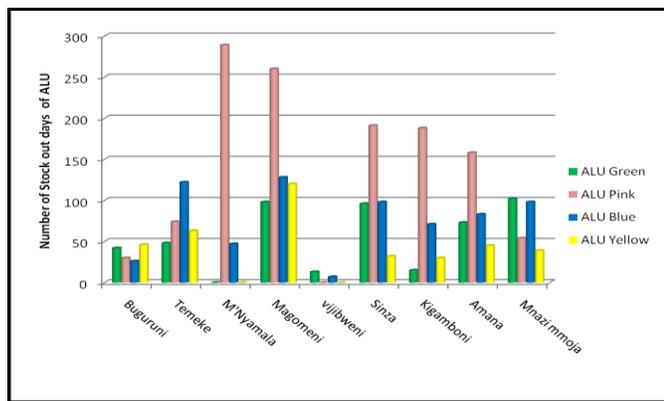
ALu Green is a pack containing 24 tablets of ALu, which is a complete dose for adults and children with more than 35 kg of body weight. Among all the visited health facilities, Mwananyamala hospital had not experienced stock-out of ALu green throughout the study year. Magomeni, Sinza and Mnazi Mmoja health centres did not have ALu green in stock for more than three months in the year 2010 (**Figure 1**).

A pack containing 18 tablets of ALu (ALu Pink) is packed to suit the complete dose for children with 26-35 kg of body weight. For this pack of ALu, it was found that Mwananyamala hospital did not have this drug for a period of 298 days in the year 2010. Other health facilities had average stock out days of 136, except Vijibweni hospital which did not experience stock out of ALu Pink in 2010 (Figure 1).

A pack of 12 tablets of ALu (ALu Blue) is a complete dose for children with 16-25 kg of weight. In this study, all the health facilities had stock out days for ALu Blue ranging from 7 to 128. ALu Yellow is a pack of 6 tablets of ALu packed to suit the complete dose for children with 5-15 kg of body weight<sup>14</sup>. The results show that all the health facilities had varied stock out days for ALu Yellow ranging from 0 to 120.

Magomeni health center had the highest number of stock out days (> three months) for ALu Yellow compared to the rest of the health facilities in the year 2010. With regard to the average percentage of stock out days for all types of ALu in the year 2010, the results show that among all the health facilities, Amana hospital had 46% as the maximum stock out days. Vijibweni hospital had average stock out days of 1.3% which was the

lowest percentage for all types of ALu tablets (**Figure 1**).



**FIGURE 1. VARIATION IN STOCK OUT DAYS OF ALL TYPES OF PACKS OF ALu TABLETS IN THE HEALTH FACILITIES FOR THE YEAR 2010.**

At the MSD, the stock out days of the antimalarial drugs especially ALu showed that the 6-pack tablets (ALu Yellow) had the highest number of stock out period (122 days), followed by 24-pack tablets (ALu Green) with 35 stock out days. It was also observed that all stock out periods for ALu especially 6-pack tablets and 24-pack tablets were

at the last three months of the year. ALu Pink was out of stock for 3 days, while ALu Blue was available throughout the year at MSD.

For quinine tablets, percentage average time out of stock in 2010 was generally high compared to ALu. Mwananyamala hospital had the highest percentage average time out of stock (53%), while Kigamboni health center had the minimum percentage average time out of stock (2%) among all the studies health facilities.

For quinine injections, five out of nine health facilities had stock-out days ranging from 9 to 68 in 2010. Buguruni health center had the highest average stock-out days (19%), while Vijibweni hospital, Sinza health center, Kigamboni health center and Mwananyamala hospital had no stock-out days for quinine injections throughout the year (**Table 1**). The average percentage time out of stock for all types of packs of ALu tablets was 11% at MSD.

**TABLE 1. AVERAGE TIME STOCK-OUT OF ANTIMALARIAL DRUGS IN THE HEALTH FACILITIES FOR THE YEAR 2010.**

Name of Health facility	Percentage Average time Stock-out of ALu and Quinine in 2010		
	ALu	Quinine tablets	Quinine injection
Amana Hospital	46	28	15
Temeke Hospital	21	No Data	3
Mwananyamala Hospital	23	53	0
Vijibweni Hospital	1.3	20	0
Magomeni Health Center	42	No Data	9
Sinza Health Center	28	22	0
Kigamboni Health Center	21	2	0
Buguruni Health Center	10	40	19
Mnazi Mmoja Health Center	37	15	12
<b>Average</b>	<b>25</b>	<b>25.7</b>	<b>6.4</b>

**Adequacy storage conditions and handling of antimalarial drugs**

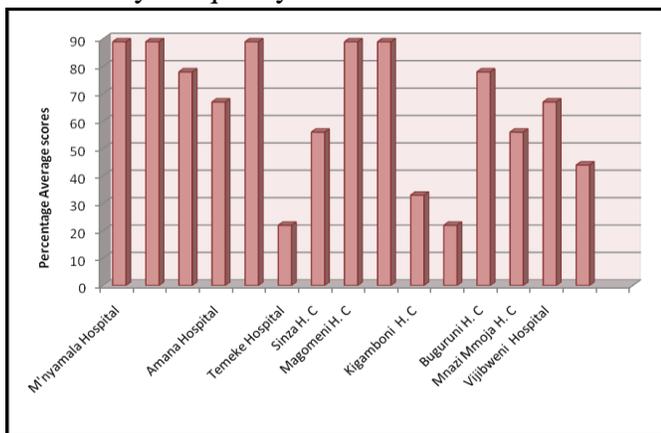
During study visits to the selected health facilities, nine main drug stores and fifteen dispensing rooms were assessed using a checklist. Results show that the percentage average scores for all the main drug stores in the public hospitals and health centers was about 64% (**Figure 2**).

Amana hospital had maximum average score of 89%, and Kigamboni health center had minimum average score of 33%. With regard to adequacy

storage conditions and handling of medicines, the overall results for the main drug stores were

satisfactory. However, all the health facilities had no cold storage with temperature chart, and 8 of them were observed to be storing medicines on the floor. Also, six main drug stores from all the visited health facilities were not keeping expired medicines in a separate place from unexpired ones. Three main drug stores had evidence of pests in the store rooms. Only six facilities were arranging their medicines in an orderly manner, with most of the facilities arranging the drugs in pharmacological

categories. The average score of dispensing rooms in all of the facilities was 65% which is generally satisfactory for quality control of medicines.



**FIGURE 2. AVERAGE SCORES FOR ADEQUACY STORAGE CONDITIONS AND HANDLING OF MEDICINES IN THE HEALTH FACILITIES.**

Results also show that in about 94% of the health facilities, expired medicines were separated from the unexpired ones. Only one dispensing room was keeping expired medicines in the same area with unexpired medicines. Medicines were found to be kept directly on the floor in six dispensing rooms. Only dispensing rooms located at Amana hospital and Buguruni health center were keeping the medicines in the shelves.

As in the case of the main drug stores, all the dispensing rooms in the health facilities had no cold storage facilities with temperature charts. Therefore control of temperature for cold-conditioned medicines was not done at all. The results further show that among all the visited dispensing rooms, about 73% of them had no dispensing tools (such as pill counting trays, or automated tablet counting machines).

**DISCUSSIONS:** This study aimed at assessing the knowledge in practice of pharmaceutical personnel for management of ALu and quinine, which are the recommended antimalarial drugs for treatment of uncomplicated and complicated malaria, respectively. Due to the shortage of pharmaceutical personnel in the public health facilities in Tanzania, the sample of the personnel who were interviewed in this study is relatively small<sup>13</sup>.

Nevertheless, the findings of this study show that the levels of qualifications of the pharmaceutical

personnel may influence the management of pharmaceuticals in the health facilities. In this study, pharmaceutical technicians were found both in the hospitals and health centers, while pharmacists were mostly found in the hospitals. Nurses who are not pharmaceutical personnel were mostly managing medicines in the health centers.

In almost all of the main stores in the hospitals pharmaceuticals were managed by one pharmaceutical personnel assisted by one subordinate, who in some cases were not pharmaceutical personnel. In the health centers, drug stores were mostly managed by non-pharmaceutical personnel. Majority of the drug store managers (67%) had poor knowledge on the concept of quantification. This proportion is slightly lower than 78% which was reported by the Ministry of Health and Social Welfare in 2008<sup>15</sup>.

Integrated Logistic System (ILS) was introduced in Tanzania in 2007 and all pharmaceutical personnel in the public health facilities were trained on its application for improving quantification processes and reducing the number of forms required to be filled for ordering medicines from MSD. In this study, there was no a unified system in the health facilities for determining the amounts of antimalarial drugs to be orders from MSD.

Pharmacists were more knowledgeable about the use of ILS compared to pharmaceutical technicians. This may due to the fact that training on ILS was provided to drug store managers, majority of which are pharmacists. However, due to the shortage of pharmacists in the public health facilities in Tanzania, pharmaceutical technicians are taking up responsibilities of managing medical stores. It is therefore necessary that continuing education on pharmaceutical management should be provided to these personnel to ensure accurate estimations and ordering of medicines in the health facilities.

Most of the health care facilities (78%) procured antimalarial drugs only from MSD, specifically those medicines which are recommended in the national malaria treatment guidelines. Advantages of procuring antimalarial and other medicines from one reliable source such as MSD is the guarantee of quality, safety and efficacy of such medicines<sup>6</sup>.

Some of the health facilities were procuring antimalarial drugs from private sectors. Such medicines included quinine injections and tablets. ALu was mostly procured from MSD because its cost is subsidized by the government for supply to the public health facilities. However, most of the drug store managers were concerned with the so called "special procurement" at MSD, the process which normally takes longer time before drugs could be delivered to the health facilities. This leads to frequent stock-outs of medicines in the health facilities and was also mentioned as one of the reasons to procure antimalarial drugs from the otherwise expensive private suppliers.

Lead time of antimalarial medicines was less than one week in the stores that were mostly managed by pharmaceutical technicians, while lead time of between one to two months were observed in the drug stores that were managed by pharmacists. The lead time of less than a week can be interpreted as ordering few items in quantities or a very short supplier delivery time. On the other hand, a longer lead time period is one of the causes for shortages of drugs in the health facilities<sup>16</sup>.

Inventory management involves a number of techniques and methods for effectiveness and efficiency. Recording system is very important for inventory management<sup>8</sup>. The main indicators that were used in this study for inventory management were the use of electronic drug recording systems (EDRS), BIN cards; and stock ledger books. There was no any health facility which was found to be using EDRS, and few of them (22%) were using BIN cards. Although EDRS is a more reliable system than others, it is highly recommended to apply all three systems for proper reconciliation of stock data<sup>6</sup>.

Poor stock records resulting from poor stock recording usually results in poor quantification outcomes especially with the use of consumption methods. As a result, this affects the availability of antimalarial and other medicines in the health facilities<sup>6</sup>. Therefore emphasis should be made to ensure that the use of EDRS and other systems for stock recordings are well established and applied effectively in the health facilities.

First In First Out (FIFO) and First Expiry First Out (FEFO) are among the known stock flow approaches in the drug stores. Among them, FEFO, which is highly recommended, is knowledge driven- approach and it minimizes the problem of drug expiry. In this study, a small proportion (11%) of drug store managers was using FEFO system to supply antimalarial and other medicines from the stores to the dispensing rooms.

This proportion is slightly higher than 5.8% that was reported in a study that was conducted in Uganda<sup>17</sup>. These findings indicate the need to promote awareness for application of FEFO stock flow approach and its advantages to drug store managers in the health facilities.

In every hospital and health center, a sufficient number of dispensing sections or satellite pharmacies is required in order to enhance effective supply of the medicines to patients and therefore minimize the waiting time by patients at the dispensing windows. In this study the mean number of dispensing sections was two per health facility. As a result, in most facilities especially in the health centers, there was long waiting time for patients to get their medicines. There is therefore a need to have adequate numbers of dispensing personnel and dispensing sections in order to improve dispensing of medicines in the health facilities.

Findings from this study show that expiry of medicines is a common problem in most of the visited health facilities in Dar es Salaam. These results are similar to those reported in other countries in Africa<sup>17, 18</sup>. Reasons given for the expiration of drugs were donated medicines with short shelf lives, preference of branded over generic medicines by patients, and poor estimation of the drugs to be procured. About a third (33%) of the respondents indicated that poor estimation of the requirements for medicines is one of the source of overstocking and hence expiry of medicines in the health facilities.

A similar study that was conducted in Uganda in 2009 reported that almost half (55.6%) of the expired medicines were obtained through donations<sup>17</sup>. Another study conducted in Malawi indicated that of the drug products currently available in the

health facilities, 65.6% were expired. Out of these, 29.8% of the expired drugs were international donations<sup>18</sup>. These findings necessitate the need for the health care facilities and ministries of health to adhere to WHO guidelines for drug donations<sup>19</sup>.

In this study, the percentage average stock out days for all types ALu ranged from 1.3 to 46 days. In addition, the overall percentage for stock of ALu in all the health facilities was 25%. This is an indication that in every 100 days during the year 2010, all types of ALu were out of stock for 25 days. This implies that patients suffering from uncomplicated malaria were either given monotherapies or other antimalarial drugs which have already been declared ineffective for management of malaria.

For quinine tablets and injection, the mean values of percentage average time out of stock were 25 and 6.4 days respectively, which are higher than the values recommended by WHO guidelines. These results also suggest that even management of complicated malaria is affected by the availability of quinine in the health facilities. The results further show that there is no significant association between stock out of antimalarial drugs at the MSD with that in the health facilities. Therefore the main reason for frequent stock out of antimalarial drugs in the health facilities is poor forecasting and quantification. Similar reasons for frequent stock out of ALu in the health facilities were also reported in Kenya<sup>20</sup>.

Shortage of antimalarial medicines with stock out days of 42 to 138 days was also reported in Malawi<sup>21</sup>. However, in the later study the main reason was insufficient deliveries of medicines from the regional medical stores. Taken together, these findings emphasize the need to build capacity of drug store managers for quantification and forecasting of medicines through provision of continuing education and professional development<sup>22</sup>.

Most of the visited health facilities' main drug stores had satisfactory scores (64% mean score) for storage and handling of medicines. This figure is comparatively lower than the score of 80% reported by the Ministry of Health in Uganda<sup>17</sup>. This percentage is also lower compared to 75%

which was reported in 2006 by WHO for lower income countries<sup>23</sup>. Even though the health facilities in this study had satisfactory storage conditions for antimalarial drugs, almost all of them had no cold storage facilities with temperature charts, and medicines were stored directly on the floor and expired medicines were kept in the same area with unexpired ones.

In the dispensing rooms, the average score for storage and handling of medicines was 65%, which is relatively higher than that reported by WHO (55%) for the public health facilities in other developing countries<sup>23</sup>. Most (73%) of the health facilities also did not have dispensing tools, and therefore tablets were counted using bare hands with potential for contamination of medicines<sup>24</sup>.

**CONCLUSION:** Poor pharmaceutical management of antimalarial medicines including lack of knowledge for drug store managers to forecast the required amounts of drugs and inventory management have been identified in this study as the main reasons for frequent stock outs and expiry of ALu in the public health facilities. Moreover, storage conditions and handling of antimalarial drugs in the health facilities are not adequate to guarantee the required quality of these drugs in these facilities. These findings necessitate the need for provision of regular on-job training and continuing education among pharmaceutical personnel in the public health facilities.

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