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**Assessment of Antimicrobial Resistance Containment  
Practices in Selected Public Hospitals of Addis Ababa,  
Ethiopia**

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## **Abstract**

**Introduction:** Ethiopia experiences a heavy burden of infectious diseases with a growing prevalence of disease morbidity and mortality. With the increased intensity of antimicrobial use following the increased burden of infectious disease in Ethiopia, AMR remains being a huge concern in the progress of treating infectious diseases. Health care facilities, particularly those which provide service to large number of patients, are a focal point in the emergence of AMR.

**Objectives:** To assess the AMR containment practices in selected public hospitals of Addis Ababa, Ethiopia.

**Methods:** Cross sectional survey was conducted in six selected public hospitals of Addis Ababa, Ethiopia between September and November, 2013. The study involved the use of mixed method approach. Quantitative data was collected by using structured self-administered questionnaires whereas the qualitative data collection methods employed key informant interviews and an observation using check list.

**Results:** Of those approached 763 healthcare professionals, 667 completed the survey questionnaires making up 87.4% response rate. The study revealed that as many as 321 (48.1%) of the total respondents had poor knowledge on AMR containment. Physicians and nurses were found to have the largest and lowest proportion of good knowledge level respectively. A significant association ( $p < 0.05$ ) was found between professional qualification and knowledge level of the respondents. The apparent lack of recent training experience was supported by the findings of lower knowledge level about AMR containment.

**Conclusion and Recommendations:** The study revealed poor knowledge level of health care professionals and poor implementation of AMR containment practices in the selected hospitals. Hence, strengthening infection prevention and control practices, ensuring adequate and consistent supply of antibiotics and infection prevention and control materials, organizing training programs on AMR containment for healthcare professional, enhancing laboratory service and initiating surveillance of new infections and AMR are the prominent recommendations for improving the AMR containment practice in the assessed hospitals.

# 1. Introduction

Infectious diseases are the most common causes of morbidity and mortality, particularly in developing countries. Use of antimicrobials has contributed to the dramatic fall in morbidity and mortality from these diseases. However, Antimicrobial resistance (AMR) has emerged as a major public health problem all over the world and seriously threatened control of infectious disease resulting in prolonged illness and greater risk of death (WHO, 2011; Abebe *etal.*, 2012).

AMR is resistance of a microorganism to an antimicrobial medicine to which it was previously sensitive. Resistant microorganisms are able to withstand attack by antimicrobial medicines, such as antibiotics, antivirals and antimalarials so that standard treatments become ineffective and infections persist and spread to others (WHO, 2012). In an increasingly interconnected world, the problems posed by drug resistance have started to threaten global public health. Weak or non-existent prevention and management of infectious disease and ill-informed and inappropriate drug use may create the petri dish out of which drug resistance emerges and then spreads around the globe (Center for Global Development, 2009).

Hospitals worldwide are a critical component of the AMR problem. Resistant hospital-acquired infections are expensive to control and extremely difficult to eradicate. Failure to implement simple infection control practices in hospitals, such as hand washing and changing gloves before and after contact with patients, is a common cause of infection spread (Krämer and Khan, 2010). The devastating effects of this rapid emergence of resistance impends not only individuals and communities but the entire health care systems (USAID, 2008).

A high prevalence of endemic antimicrobial-resistant organisms in health care facilities in developing countries has been repeatedly reported (Nicolle, 2001). While increased access to necessary drugs is clearly desirable, it brings challenges in preserving the efficacy of these drugs and ensuring their appropriate use. It is absolutely vital that access to essential medicines continues to expand in developing countries to reach those in need, accompanied by specific measures to assure the safety, efficacy, sustainability and appropriate use of those drugs for a larger group of patients (Nugent *etal.*, 2010).

Resistance first emerges in populations with a high frequency of infection, due to either underlying patient status or interventions compromising host defenses, resulting in a high rate of antimicrobial use. Where patients at risk are in close proximity, the transmission of organisms between patients will be facilitated and the opportunity for a single strain to disseminate widely is enhanced. Thus, health care facilities, particularly those which provide service to large number of patients, are a focal point in the emergence of AMR (Nicolle, 2001).

## **2. Statement of the problem**

In developing countries, the role of poverty in AMR has been recognized (Planta, 2007). Poor countries and the poorest people within them bear the predominant infectious disease burden. The burden of illness disproportionately affects many low income countries of which infectious diseases involving HIV/AIDS, malaria, tuberculosis, respiratory and diarrhoeal diseases are most prevalent. In the recent past, emergence and spread of AMR in several microorganisms has rendered the management of many infectious diseases difficult. The subsequent spread of AMR in developing countries is, thus, considered a societal and economic issue (Anteneh *et al.*, 2005; Sosa *et al.*, 2010; Enato and Uwago, 2011).

Antimicrobial resistance is a threat to all branches of medical and public health practice. It challenges the control of infectious diseases, jeopardizes progress on health outcomes by increasing morbidity and mortality and imposes huge costs on societies. The costs of treating microbial infections place a significant burden on the society: a burden that is likely to grow larger as the number of cases of drug-resistant illness increases. Thus, the consequences of AMR may be felt harder in resource-poor settings (Interagency Task Force on Antimicrobial Resistance, 2011; Leung *et al.*, 2011).

In Ethiopia, the problem of AMR is significant. The major contributing factors for AMR include low adherence to treatment guidelines, shortage of antimicrobials and infection prevention materials, inadequate knowledge and practices among health care providers on antimicrobial selection and health facilities' limited action on AMR prevention and containment. These all require multiple interventions that can form synergy to prevent and contain AMR (Andualem *et al.*, 2011).

A study conducted in Gondar University Teaching Hospital has shown the susceptibility patterns of bacteria isolated from surgical site infection against selected antimicrobial agents. High level of resistance was observed against amoxicillin (95.5%), ampicillin (89.2%), cotrimoxazole (80.2%) and chloramphenicol (74.8%) (Amare *et al.*, 2011).

A study conducted in Hawassa Referral Hospital reported the *Streptococcus pneumoniae* drug resistance to the antimicrobials: ampicillin, penicillin, ceftriaxone, erythromycin, cotrimoxazole and chloramphenicol. All of the antimicrobials were tested on 31 isolates and 20 (64.2%) of the isolates were resistant to two or more of the antimicrobial agents (Daka, 2011).

A study conducted in Northeast Ethiopia on antimicrobial susceptibility pattern of *Escherichia coli* reported significantly high resistance rates to erythromycin (89.4%), amoxicillin (86.0%) and tetracycline (72.6%). When compared to the resistance rate obtained in 2003, an increment in the resistance rate of 1.2 - 34.8% was noted for these antibiotics (Kibret and Abera, 2011).

The major Plasmodium species causing malaria in Ethiopia are Plasmodium falciparum (about 60% of cases) and Plasmodium vivax (about 40% of cases). Anti-malarial drug resistance in Plasmodium falciparum and Plasmodium vivax is the most pressing problem confronting malaria control in many endemic countries (Mula *et al.*, 2011).

Health care centers, clinics and hospitals are commonly affected by AMR related problem in developing countries. Weak infection prevention and control practices lead to the increased transmission of resistant microorganisms (Leung *et al.*, 2011). Poor sanitary facilities, poor waste management and lack of awareness regarding disease transmission and control are the prominent factors responsible for the spread of AMR in health care settings (WHO, 2001). In fact, these institutions are considered in many aspects the breeding grounds for the occurrence of AMR that subsequently may spread to other previously uninfected patients and may also be a pool of resistant strains that may potentially spread to the community (Sosa *et al.*, 2010).

In many health care settings in developing countries, there is consistent lack of sufficient staff, training of staff and resources to enforce infection control practices and guidelines for rational use of antimicrobials. Intervening AMR is particularly challenging in the resource limited settings with poor healthcare infrastructures and shortage of healthcare staff (Leung *et al.*, 2011).

In view of the inseparability of the problem of resistance from mitigating factors like poverty, which also impact the overall infectious disease burden, it makes sense to pursue resistance containment as part of an overall health package. Many interventions including national disease control and management programs, which improve health care in general, could assist in containing resistance (Sosa *et al.*, 2010). Since the intensity of antimicrobial use in hospitals is far higher; hospitals are particularly important in the containment of AMR. Significant health and economic benefits are then possible through efforts to reduce AMR in hospital settings (Interagency Task Force on Antimicrobial Resistance, 2011).

In 2001, WHO released a global strategy to contain the problem of AMR. However, few AMR containment programs have been implemented in resource-constrained countries (Strengthening Pharmaceutical Systems, 2008). With the increased intensity of antimicrobial use following the increased burden of infectious disease in Ethiopia, as in most of the developing countries, AMR remains being a huge concern in the progress of treating infectious diseases. As little is known regarding the implementations of AMR containment practices in Ethiopian health institutions, the study aimed to assess the AMR containment practice in the selected public hospitals of Addis Ababa, Ethiopia.

### **3. Literature Review**

#### **3.1. Antimicrobial resistance: emergence and causes**

Antimicrobial resistance has become a global public health problem. The burden of AMR worldwide is substantial and is likely to grow. Many factors play a role in the emergence of resistance such as poor utilization of antimicrobial agents, transmission of resistant bacteria from patient to patient and from health care workers to patients and vice versa. Although many factors contribute to this deteriorating situation, the use of antimicrobials is the single most important determinant of resistance. Overuse and misuse result from poor prescribing behaviour, uninformed patient demand and lack of adherence to the treatment regimen prescribed. Low-quality drug formulations, inadequate dosage regimens and insufficient duration of therapy are also important contributors to AMR (Simonsen *et al.*, 2004; Aly and Balkhy, 2012).

Fueled by increasing antimicrobial use, the frequency of resistance escalated in many different bacteria, especially in developing countries where antimicrobials were readily available without prescription (Levy and Marshall, 2004). Drug-resistant infections may be acquired in healthcare settings, in the community and through the food supply. While anyone may acquire a drug-resistant infection, certain people, such as patients in hospitals, are at increased risk (Interagency Task Force on Antimicrobial Resistance, 2011).

Health facilities, particularly acute care facilities, are important sites for the development of AMR. The intensity of antimicrobial use together with populations highly susceptible to infection creates an environment which facilitates both the emergence and transmission of resistant organisms (Nicolle, 2001). The aggregation of highly susceptible patients, the intensive and prolonged use of antibiotics and the lack of implementation of standard practices for infection control are often responsible for the emergence, selection and spread of multi-resistant pathogens in hospitals and other health-care settings (Simonsen *et al.*, 2004).

The burden of resistant infection is disproportionately borne by the less privileged. Evidence is accumulating to suggest that the emergence and spread of resistance is strongly influenced by socioeconomic factors at the individual and national levels. Poverty influences downstream factors that could alter selective pressure for resistance and promote the dissemination of resistant strains (Sosa *et al.*, 2010).

Antimicrobial resistance rates might be higher in areas where antimicrobial use is not controlled compared with areas where antimicrobial use is restricted (Jumaa and Neringer, 2005). But in Africa, the situation is more complex than simple antimicrobial overuse. Increasing AMR in Africa has been exacerbated by multiple factors, for instance, the human resource problem in the health sector in sub-Saharan Africa has reached crisis proportions. There are not enough trained staffs and adequate laboratory facilities. These lead to the extensive use of antimicrobial drugs which have favored the emergence of resistant strains (Kimang'a, 2012).

By and large, the reasons for increasing resistance levels include: overuse and misuse of antimicrobials for prophylaxis and treatment of infection, noncompliance with infection-control practices, multiple comorbidities in hospitalized patients, ineffective infection-control practices, transfer of colonized patients from hospital to hospital, grouping of colonized patients in long term care facilities and failure of patients to complete the prescribed course of antimicrobials. All of these factors must be addressed in order to control the spread of antimicrobial-resistant organisms (Kardas *et al.*, 2005; Warren, 2007; Byarugaba, 2010).

### **3.2. Consequences of AMR**

Antimicrobial resistance jeopardizes the effectiveness of the treatment of bacterial, viral, fungal and parasitic infections worldwide (Simonsen *et al.*, 2004). The ability of microorganisms to become resistant to the major therapies used against them has long been recognized and is becoming increasingly apparent. Increasing AMR presents a major threat to public health because it reduces the effectiveness of antimicrobial treatment, leading to increased morbidity, mortality and health care expenditure (Smith and Coast, 2002). AMR impinges on the quality of patient care through its associated morbidity, mortality and significant economic consequences and contributes to the global specter of a post-

antimicrobial era in which some of the most effective antimicrobials lose their effectiveness (Anteneh *etal.*, 2005).

AMR costs lives and the consequences can be most profound for children, who are especially susceptible to infectious diseases. The most common diseases in developing countries malaria, pneumonia, other respiratory infections and dysentery are no longer curable by many of the older antibiotics. The consequences are devastating: bacterial acute respiratory infections, for example, kill more than three million children every year (Nugent *etal.*, 2010).

### **3.3. AMR Containment Strategies**

Containment of AMR requires a range of strategies. The eradication of AMR requires optimizing the effective use of antimicrobials against infection, thus, reducing morbidity, mortality and further spread of infection (Smith and Coast, 2002). An effective strategy to limit the effect of drug resistance must be multifaceted and must include education of patients and physicians about appropriate antimicrobial use, use of effective infection control practices to prevent transmission from infected to uninfected patients, surveillance of AMR and antimicrobial use and development of alternative therapies that may, in some cases, circumvent the need for antimicrobial therapy (McDonald, 2006).

Controlling AMR in developing countries in the future will require both diminishing the inappropriate use of antimicrobial agents that leads to the development of resistance and improving the social and environmental conditions that currently cause the high incidence of infectious diseases (Sosa *etal.*, 2010).

#### **3.3.1. AMR containment in hospital settings**

While resistance can and does appear in any setting, hospitals featuring the combination of highly susceptible patients, intensive and prolonged antimicrobial use and cross-infection have become a hot spot for highly resistant pathogens. Transmission of highly resistant pathogens from patient to patient within the hospital environment amplifies the problem of AMR and may result in the infection of patients who are not receiving antimicrobials (WHO, 2001).

Developing institution-based AMR containment strategies is important since hospital-acquired infections have a substantial impact on morbidity and mortality, hospitals consume a disproportionate share of healthcare budgets, they are the major nidus for the emergence of resistant bacteria, they amplify spread of resistance since the microorganisms can spread quickly among patients and patients who acquire resistant infections in hospitals have the potential to disseminate resistant microorganisms into their homes and communities (Kimang'a, 2012).

The growing threat of AMR demands an extensive and systematic global response. Patients, prescribers and dispensers must all gain greater awareness of the personal and social costs of drug resistance and employ far greater diligence in appropriately using drugs (Nugent *et al.*, 2010). Management of the problem of AMR within hospitals requires good stewardship of antibiotic usage combined with strong infection control. To achieve this, all levels of personnel within the hospital must be involved, from top administration down to individuals performing services and providing patient care (Shales *et al.*, 1997).

The following nine interventions majorly contribute to AMR containment within health facilities (USAID/MSH, 2008):

1. Developing and implementing drug and therapeutics committees (DTC)
2. Developing and maintaining hospital essential medicines lists and formularies
3. Developing standard treatment guidelines
4. Disseminating and implementing standard treatment guidelines
5. Investigating antimicrobial use and implementing a medicine use evaluation program
6. Training to develop and implement hospital infection control programs
7. Developing and implementing AMR containment training material
8. Integrate into continuing medical education programs and
9. Improving AMR surveillance capacity

According to the WHO Global Strategy for Containment of AMR, establishment and implementation of hospital infection prevention and control programme is mandatory for effective management of AMR in hospital (WHO, 2001). In health care facilities, the infection prevention and control programme is one of three essential overlapping programmes with activities which address the problem of AMR. The second activity, which is clinical microbiology laboratory, provides isolation and susceptibility testing of organisms from clinical specimens and surveillance data to summarize the prevalence of AMR in a facility. The third essential activity is the antimicrobial use programme which makes recommendations for antimicrobials for the hospital formulary considering the impact of AMR both for the individual infected patient as well as the environment and monitors antimicrobial use in the facility. These three programmes must function cooperatively to support the goal of AMR containment (Nicolle, 2001).

DTCs are among the most critical interventions to curb the emergence and spread of AMR in healthcare institutions. These committees manage the selection of medicines for the formulary, evaluate medicine use and implement strategies to improve medicine use throughout the healthcare system. Many hospitals and health facilities in resource limited settings, however, either lack DTCs or do not manage them efficiently (USAID/SPS, 2010). The DTC should maintain responsibility for antimicrobial policy management in response to national guidelines, local requirements and susceptibility data and should take responsibility for prudent antimicrobial prescribing by developing and implementing guidelines (MacKenzie, 2006).

### **3.3.2. National strategic framework for AMR prevention and containment**

Food, Medicine and Health Care Administration and Control Authority of Ethiopia (FMHACA), developed a national strategic framework for prevention and containment of AMR. This national strategic framework is designed to make the WHO Global Strategy for AMR Containment operational at country level and facilitate the efforts in minimizing the morbidity and mortality due to resistant infections and preserving the effectiveness of antimicrobial medicines.

The national strategy addresses the following key strategic issues (FMHACA, 2013):

- Establishing national alliance for prevention and containment of AMR
- Instituting a surveillance system that captures the emergence of resistance, trends, its spread and utilization of antimicrobial medicines in different settings
- Strengthen infection prevention and control measures to reduce disease burden
- Promoting rational use of antimicrobial medicines at all levels of healthcare and veterinary settings
- Supporting research and education in the area of AMR prevention and containment

## **4. Objectives**

### **4.1. General Objective**

- To assess AMR containment practices in selected public hospitals in Addis Ababa, Ethiopia

### **4.2. Specific Objectives**

- To assess the knowledge, attitude and practice of health professionals working in the selected public hospitals regarding AMR with special emphasis to AMR containment
- To describe the current AMR containment practices in the selected public hospitals
- To identify factors influencing the AMR containment practices in the selected public hospitals

## **5. Materials and Methods**

### **5.1. Study setting**

The study was conducted in Addis Ababa, Ethiopia. There are a total of 14 government owned hospitals in Addis Ababa of which four are under the Federal Ministry of Health (FMoH), one is a university hospital under Addis Ababa University, six are general hospitals under the Addis Ababa City Administration Health Bureau (AACAHB) and the other three are Army and Police Hospitals. With the exception of Army and Police hospitals, the remaining government owned hospitals are public hospitals. The study was conducted in six government owned public hospitals; one teaching hospital under Addis Ababa University (Tikur Anbessa Specialized Hospital), three hospitals under AACAHB (Minilik II, Yekatit 12 and Zewditu Memorial Hospitals) and two hospitals under the FMoH (St. Paul and St Peter TB Specialized Hospitals).

### **5.2. Study design**

Hospital based descriptive cross sectional survey was conducted from September to November, 2013 in the selected public hospitals of Addis Ababa. The study involved the use of mixed method approach where both quantitative and qualitative methods were used. Quantitative approach was employed to assess the knowledge, attitude and practice (KAP) of health care professionals towards AMR with special emphasis to AMR containment. Qualitative approach was employed to describe the AMR containment practice in the selected hospitals and to identify the factors that may potentially influence the AMR containment practice in the hospital settings.

### **5.3. Study population**

Health professionals practicing in the selected public hospitals of Addis Ababa, Ethiopia were the study population. Study participants for the KAP survey concerning AMR and its containment practices were recruited using quota sampling technique. The key informant interviewees were selected purposively.

#### 5.4. Inclusion and exclusion criteria

- **Inclusion criteria:** healthcare professionals with a minimum of six months work experience who were practicing in the selected public hospitals during the data collection period
- **Exclusion criteria:** healthcare professionals with less than 6 months work experience and medical doctors who do not frequently prescribe antimicrobials including physicians working in radiology, psychiatry, ophthalmology and anesthesiology departments.

#### 5.5. Sample size determination and sampling procedure

- **Sample size determination**

The minimum sample size (n) required for the KAP survey was computed using single population proportion formula (Fosgate, 2009)  $n = \frac{(Z_{\alpha/2})^2 \times P(1-P)}{d^2}$

Where: n= minimum sample size

P= Expected proportion of good knowledge (50%)

$Z_{\alpha/2}$ = Critical value for a given confidence interval (with 95% CI)

d= margin of error (5%)

$$n = \frac{(1.96)^2 \times 0.5(0.5)}{(0.05)^2} = 384$$

Design effect (of 2) was considered and made up a sample size of 768. The calculated sample size was adjusted using the formula (Fosgate, 2009),

Corrected sample size =  $\frac{n \times N}{n + N}$ ; where N is the size of the source population; 3692

N= 3692 (Total number of health professionals practicing in public hospitals in Addis Ababa, Ethiopia)

$$\text{Corrected sample size} = \frac{768 \times 3692}{768 + 3692} = 636$$

To compensate for possible non-response for the self-administered questionnaires, 20 % of the corrected sample size (127) was added and made up the final sample size of 763.

- **Sampling procedure**

As shown in Figure 1, the study hospitals were selected using stratified sampling technique based on ownership criterion and included six public hospitals. These were: Tikur Anbessa Specialized, Zewditu Memorial, St Peter TB specialized, Minilik II, Yekatit 12 and St Paul Hospitals. As depicted in Figure 2, for the KAP survey respondents were stratified based on profession and the distribution of the total sample size for each professional category (physicians, nurses, pharmacy and laboratory professionals) had been proportionately determined based on the total number of health care professionals working in the selected public hospitals. Then, by using the human resource profile of the respective hospitals, the sample size was proportionately allocated for each selected hospital. Recruitment of the respondents was achieved through quota sampling technique. For the key-informant interview, participants were purposively selected so that an in-depth understanding of the subject matter is achieved.

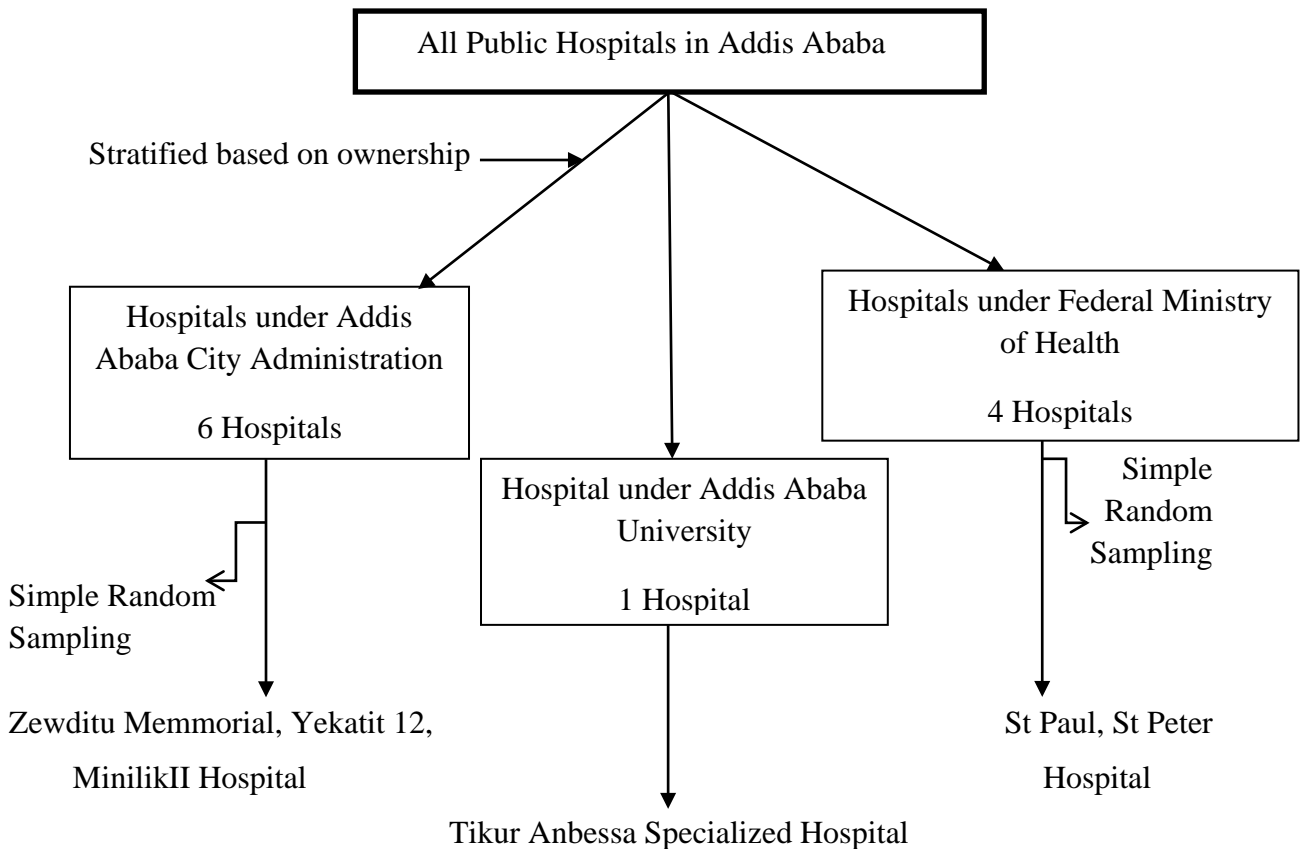


Figure 1: Schematic representation of sampling techniques employed for the selection of hospitals

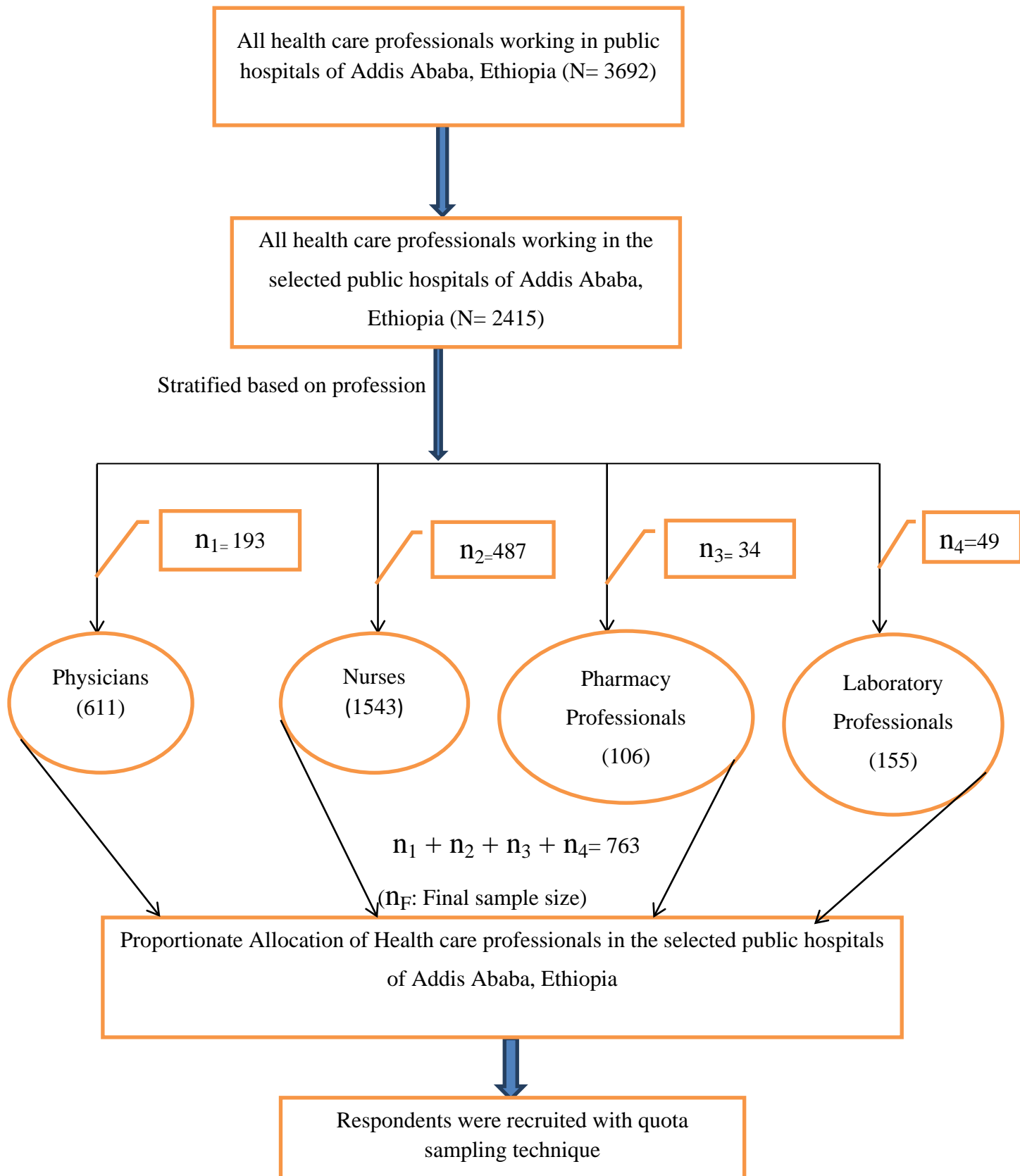


Figure 2: Schematic representation of sampling techniques employed for the selection of health care professionals for the KAP survey

## 5.6. Method of data collection

- **Data collection instruments**

For the KAP survey, depending on the qualification of respondents, four different self-administered questionnaires were used (Annex I). The questionnaires had four sections; demographics, knowledge, attitude and practice sections. Except for the demographic and practice sections, the composition of each section was the same for all respondents. The questionnaires were adopted from WHO guideline on AMR containment and from other instruments that had been previously employed by other similar study (WHO, 2001; Garcia *etal.*, 2011).

A total of 15 knowledge assessment questions were incorporated in the questionnaires to assess the knowledge of healthcare professionals regarding AMR and its containment. Seven “true” or “false” questions were designed to capture the general knowledge of the healthcare professionals regarding AMR and its driving factors for its spread in hospital settings. The other eight questions were peculiarly designed to measure the knowledge level of health care professionals on WHO recommended AMR containment strategies for hospital settings. Questions on respondents’ attitude towards AMR and its containment employed a 5-point Likert scale with response options varying from “strongly agree” to “strongly disagree”. Practice assessment questions were designed in accordance with the professional qualification of respondents.

For the key informant interviews, semi-structured interview guides (Annex II) with flexible probing ideas were used for investigating personal experiences from the subjective perspective of each respondent. The interview guide was adopted from WHO guideline and previously employed assessment tool on antibiotic use and AMR in hospital settings that was prepared in English language (WHO, 2001; EPN, 2010). The structural outlay of patients triage and wards, conduciveness of the hospital environment, availability and accessibility of hand hygiene facilities as well as materials and other infection control measures had been assessed through observation using an infection control assessment checklist (Annex III) (RPM plus, 2006).

- **Recruitment and training of data collectors**

Four data collectors from Addis Ababa University, School of Pharmacy undergraduate program were recruited for the KAP survey and trained on data collection procedures and ethical issues. As part of the training, the data collectors conducted a pre-test of the instruments with the guidance of the principal investigator.

- **Data collection**

Prior to the distribution of the questionnaires, all participants were explained about the objective and importance of the research by the principal investigator and data collectors. Each participant was also asked to complete all sections of the questionnaire. Participants were engaged in the study based on their willingness to participate.

The distribution of self-administered questionnaires was managed separately and systematically in line with the professional category of survey respondents. For physicians, the instruments were mostly distributed during morning sessions but only in few cases, it had been distributed in their office. For nurses, prior to the distribution of the questionnaires the head nurses or senior nurses in each ward was contacted and explained about the objective of the study in order to ease the organization of respondents, to minimize non response rate and facilitate collection of data in a timely manner. For pharmacy and laboratory professionals, questionnaires were distributed on site during working hours. The survey questionnaires were collected back both by the principal investigator and research assistants.

Health care professionals from various departments (infectious disease specialists, head nurses, head pharmacists, microbiologists and laboratory professionals, infection prevention and control committee members and disease prevention and patient safety officers) of the selected hospitals were identified and purposively selected for recruitment as key informants. They were explained about the objectives and importance of the research. They were asked for their willingness to participate in the study and were also informed to provide the correct and timely information. Permission for recording was asked during the data collection not to miss out information. The principal investigator administered the key informant interviews and facility assessment observation.

## 5.7. Description of variables

- **Dependent variable**

Knowledge of health professionals regarding AMR and its containment practices.

- **Independent variable**

- Age
- Sex
- Profession
- Professional work experience
- Training experience on AMR and its containment

## 5.8. Data quality assurance

The entire data collection instruments (both quantitative and qualitative data collection instruments) were pre-tested to increase the quality of the responses. The pre-test helped to rectify and revise instruments as well as the research procedures in general. Daily supervision was made by the principal investigator during the whole data collection period and any inconsistencies were amended on time. Regular cross checking, inspection and scrutinizing of information on the data collection instruments were also done to ensure completeness of the data.

Two couples of questions composed of similar and contradictory questions had been aligned in the attitude section of the questionnaire's structure in order to ensure the consistency of responses and avoid errors arising from the effect of random completion of questionnaires. All were randomly placed in the questionnaire so that it can't easily be identified. Once the data collection begun, data was checked every day for the completeness of the information and inspected for the accuracy using those couples of questions. Incomplete and inconsistent data (based on the couple questions) were discarded.

## **5.9. Data entry and analysis**

After the data collection, the principal investigator coded each question and data entry was made using EPI-INFO version 3.5.1 statistical packages and the data was transported to SPSS version 16 for data analysis. Descriptive statistics such as frequencies and percentages were used to describe and summarize the data. Statistical associations of study variables was assessed using chi square analysis with 95% confidence interval ( $p < 0.05$ ).

The qualitative data was analyzed with a view to gain an understanding of AMR containment practices in the selected hospitals. The analysis was solely done by the principal investigator. Themes were identified and thematic analysis had been conducted, focusing on similarities and differences of perspectives between different respondents. Themes that appear similar were analyzed together and all of the information gathered from this qualitative tool was analyzed to capture the different perspectives of all participants. Data that was obtained from the facility assessment observation checklist had also been used in the qualitative data analysis.

## **5.10. Ethical considerations**

Approval had been sought from Addis Ababa University, School of Pharmacy Research and Ethics Review Committee. The study was conducted after securing further permission from the selected health institutions.

Informed verbal consent process involved the principal investigator and the data collectors verbal explanation to each potential participants' on the nature of the study, its purpose, procedures and expected duration. Each participant was informed that participation in the study was voluntary. The participants were assured that all information gathered would be treated as confidential. The name of study participants were not recorded on the self-administered questionnaires to assure anonymity.

### **5.11. Operational definitions**

Operational definitions for healthcare professionals, good, fair and poor knowledge were set by the principal investigator.

- **Healthcare professionals:** In this study, healthcare professionals refers to physicians, nurses, pharmacy and laboratory professionals
- **Good knowledge:** In this study, good knowledge on AMR containment refers to knowledge score obtained above the median value of 6 out of 8 questions
- **Fair knowledge:** In this study, fair knowledge on AMR containment refers to knowledge score obtained equal to the median value of 6 out of 8 questions
- **Poor Knowledge:** In this study, poor knowledge on AMR containment refers to knowledge score less than the median value of 6
- **Antimicrobial stewardship:** It has been defined as the optimal selection, dosage, and duration of antimicrobial treatment that results in the best clinical outcome for the treatment or prevention of infection, with minimal toxicity to the patient and minimal impact on subsequent resistance (Doron and Davidson, 2011).

## **6. Result**

### **6.1. Knowledge, attitude and practice survey results**

#### **6.1.1. Respondents' demographic characteristics**

Of those approached 763 health care professionals, 667 completed the survey questionnaires making up response rate of 87.4%. The summary of demographic characteristics of survey respondents is presented in Table 1. Females accounted for majority 387(58%)of the total sample. The age of respondents ranged from 20 to 62 years with mean age of 29.7 years (SD=7.3 years). Among the respondents, 175(26.2%) were physicians, 420(63%) were nurses, 31(4.6%) were pharmacy professionals and 41(6.1%) were laboratory professionals. The minimum and maximum years of respondents professional experience was 1 and 34 years respectively.

#### **Respondents' training experience on AMR and its containment**

One hundred seventy eight (26.7%) of the respondents claimed that they had taken training regarding AMR and its containment within the last six months.

Table 1: Demographic characteristics of survey respondents in selected public hospitals of Addis Ababa, Ethiopia, 2013

Variables	Frequency (N=667)	Percentage (%)
<b>Gender</b>		
Male	280	42
Female	387	58
<b>Age in Years</b>		
20 – 25	267	40
26 – 30	223	33.4
31 – 35	83	12.4
36 – 40	37	5.5
41 – 45	26	3.9
Over 45	31	4.6
<b>Professional qualification</b>		
Physicians	175	26.2
Nurses	420	63
Pharmacy professionals	31	4.6
Laboratory professionals	41	6.1
<b>Years of Professional Service</b>		
< 2	210	31.5
2 - 5	223	33.4
6 – 10	122	18.3
Over 10	112	16.8

## **6.1.2. Survey respondents' knowledge about AMR and its containment**

### **6.1.2.1. General knowledge about AMR**

General knowledge of healthcare professionals towards AMR was assessed by asking them about factors that contribute for the overall spread of AMR in hospital settings. Seven questions with “True” or “False” response category were presented to the respondents. The majority 570(85.5%) of respondents had adequate knowledge regarding the relationship between AMR and irrational prescribing practice and irrational use of antimicrobials. As many as 583(87.4%) of the respondents had adequate knowledge regarding the impact of patients exposure to antimicrobial agents and AMR development. However, relatively lower knowledge had been noted regarding the role of hospital formularies (hospital drug lists) in AMR control 437(65.5%) and the effect of air circulation system on the spread of infections and AMR 242(36.3%).

Table 2: Health professionals' correct response to knowledge assessment variables regarding AMR, in selected public hospitals of Addis Ababa, Ethiopia, 2013

Knowledge assessment variables	Correct response (%) (N= 667)
AMR is directly linked to irrational prescribing and irrational use of antimicrobials	True (85.5%)
Empiric antimicrobial therapy aggravates the problem of AMR	True (86.2%)
Duration of exposure to antimicrobials influence the likelihood of colonization with resistant microorganisms	True (87.4%)
Problem of AMR doesn't depend on the consistency of antimicrobial supply	False (70.3%)
Hospital drug formularies (drug list) do not have a role in AMR control	False (65.5%)
Patient overcrowding contributes for the spread of infection and AMR	True (93.9%)
Air circulation system in hospital settings doesn't have any effect in the spread of infections and AMR	False (36.3%)

### 6.1.2.2. Knowledge about AMR containment

Eight markedly designed questions were used to measure the knowledge level of healthcare professionals about AMR containment. As illustrated in Figure 3, majority of the respondents respond that hand hygiene 548(82.2%), sanitary control of the hospital environment 451(67.6%), use of aseptic techniques for medical and nursing procedures 455(68.2%) and using laboratory findings in diagnosis of infectious etiologies 472(70.8%) must be incorporated in healthcare settings for the management of AMR containment. Poor knowledge of health professionals had been identified concerning surveillance of new infections and AMR 289(43.3%), control of antimicrobial use and antimicrobial restrictions 316(47.4%) and implementation of barrier precautions and isolation procedures 381(57.1%).

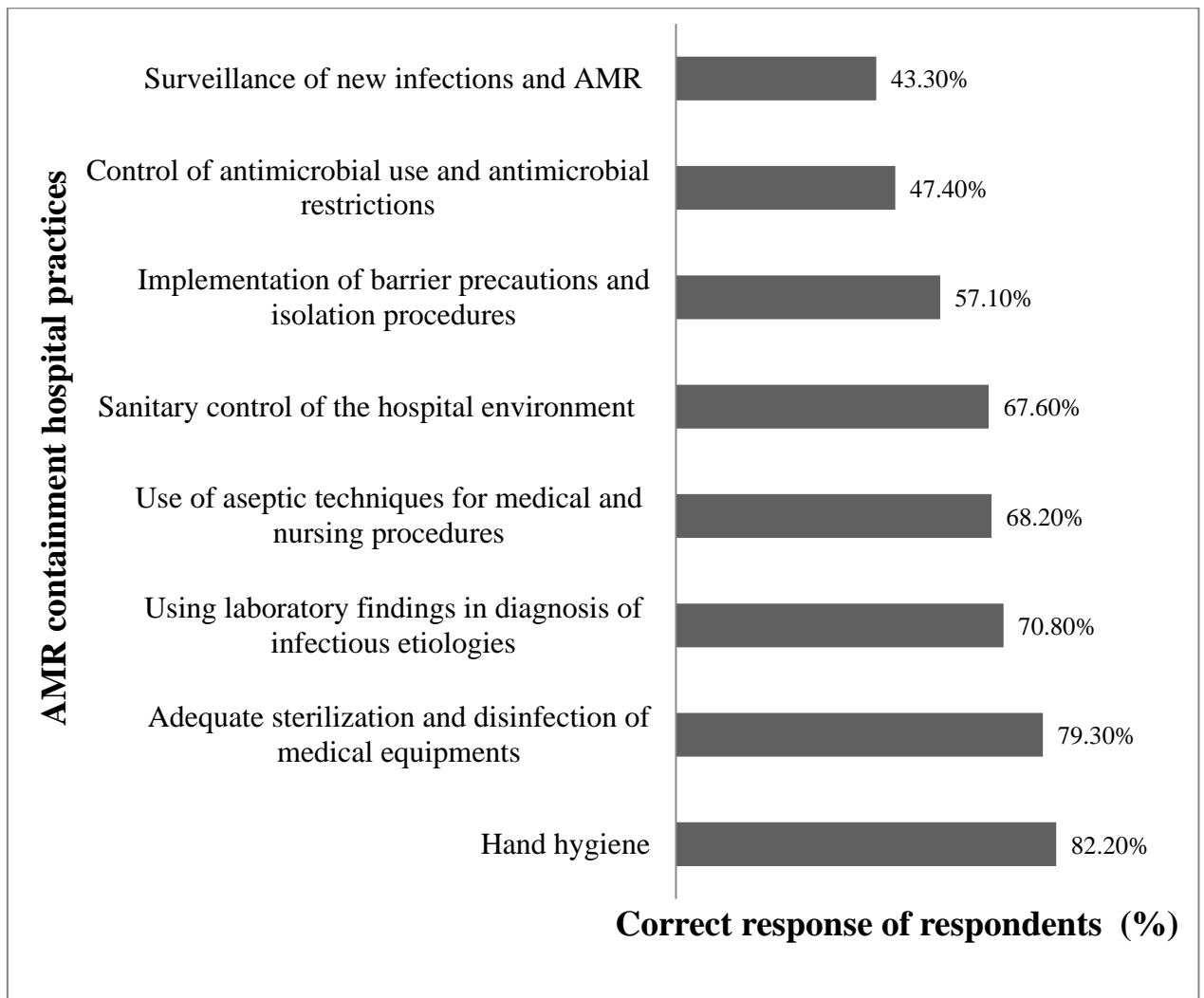


Figure 3: Health professionals' knowledge on AMR containment, in the selected public hospitals of Addis Ababa, Ethiopia, 2013

The knowledge of respondents on these eight variables was summed up and made up a total knowledge score on AMR containment. The total measured knowledge score was then used to determine the knowledge level of respondents. The median value of the knowledge score (6) was used as a cutoff point to categorize the knowledge level into three; poor knowledge (if knowledge score is below the median value 6), fair knowledge (if the knowledge score equals the median value 6) and good knowledge (if knowledge score is higher than the median value 6). Accordingly, as many as 321(48.1%) of the total respondents had poor knowledge, 82(12.3%) had fair knowledge and 264(39.6%) had good knowledge on AMR containment. As shown in Figure 4, the largest and lowest proportion of good knowledge level was found among physicians and nurses respectively.

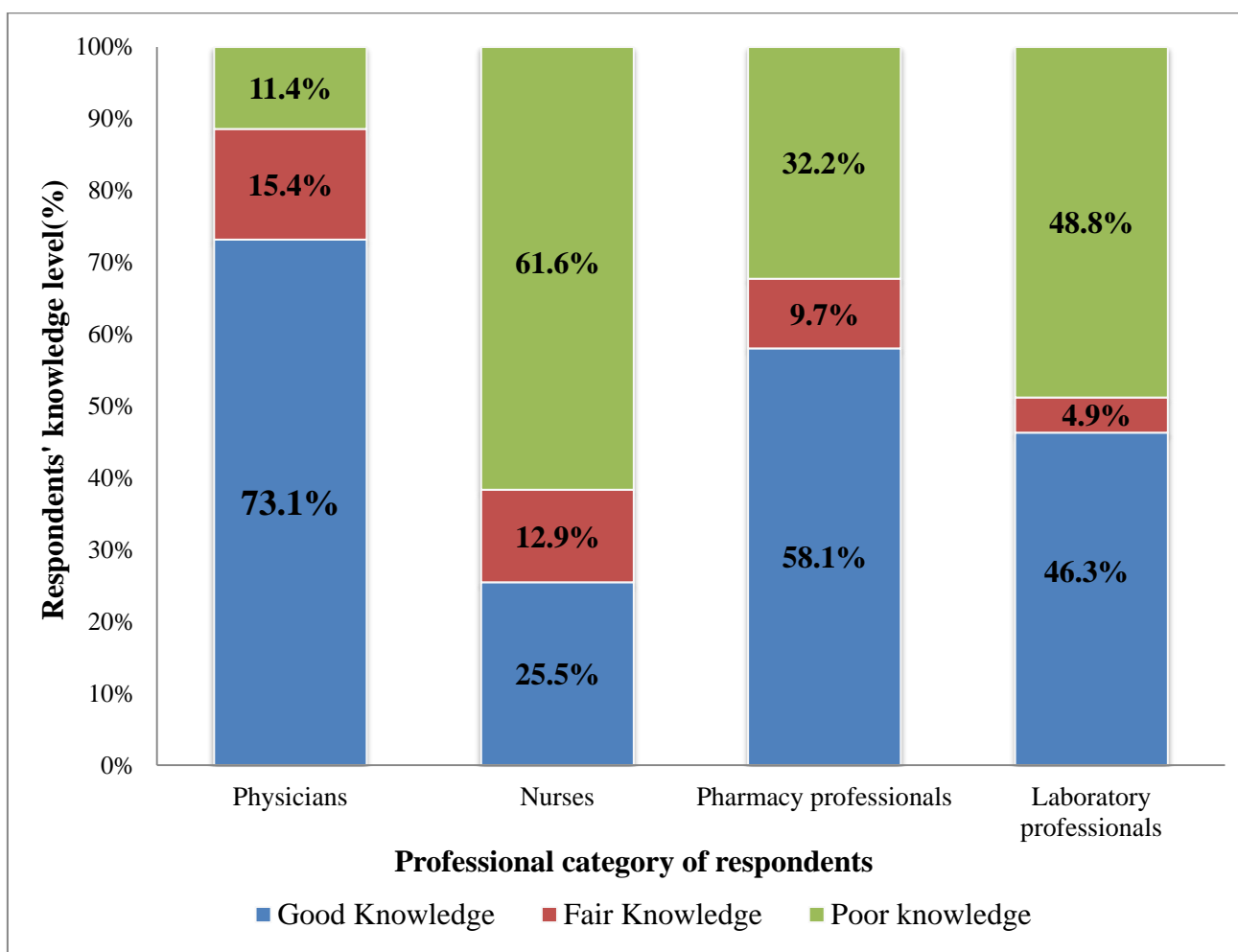


Figure 4: Respondents' knowledge level on AMR containment among different professional categories

### 6.1.3. Survey respondents' attitude towards AMR and its containment

#### 6.1.3.1. Attitude towards AMR problem in hospital settings

The attitude of health professionals regarding the problem of AMR in hospital settings related to antimicrobials prescribing and use is illustrated in figure 5. The majority of respondents agreed and strongly agreed towards AMR and overuse of antimicrobials being a significant problem in their respective facilities. Majority of the respondents also agreed and strongly agreed with the statement which says “representatives of pharmaceutical companies influence prescriber’s choice of antibiotic towards broad-spectrum antibiotics.

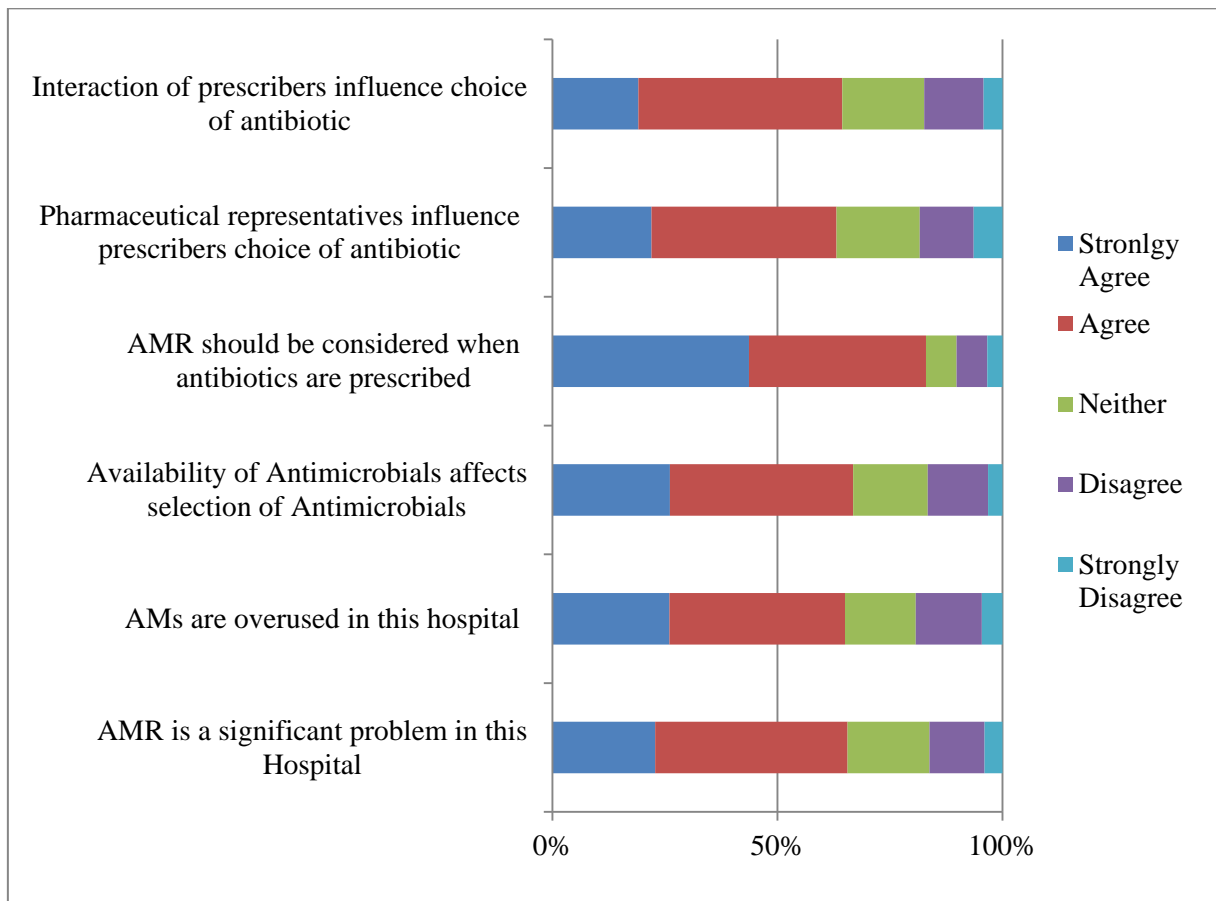


Figure 5: Attitude of health care professionals towards AMR, in the selected public hospitals of Addis Ababa, Ethiopia, 2013

### 6.1.3.2. Attitude towards the implementation of AMR containment practices

As illustrated in figure 6, the majority of respondents agreed and strongly agreed that health professionals have poor awareness regarding AMR and AMR containment and so, organization of training programmes is desirable. They also reported unsatisfactory implementation of infection control practice in their hospital, poor availability and accessibility of infection control facilities, poor tracking of causes for new infections and AMR in the hospital and also poor handwashing practices among healthcare professionals. Majority of respondents stated their disagreement regarding the advantage of locally developed drug formularies over national guidelines.

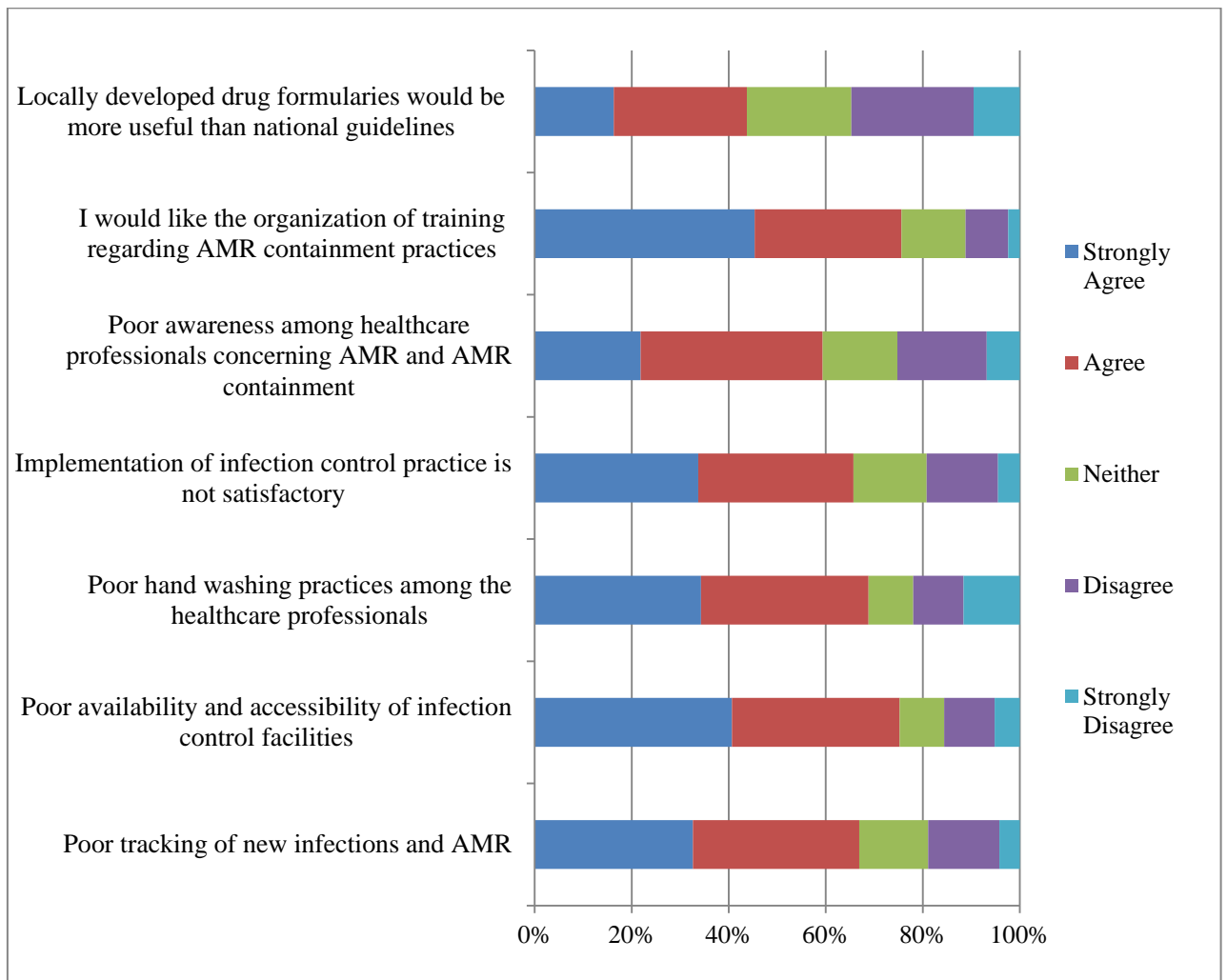


Figure 6: Attitude of health care professionals towards the implementation of AMR containment, in the selected public hospitals of Addis Ababa, Ethiopia, 2013

#### **6.1.4. Survey respondents' AMR containment practice**

##### **6.1.4.1. Physicians' infection prevention and control and rational prescribing practice**

Of all physicians (N=175) that were assessed in the KAP survey, 26(14.9%) of them were specialists. One hundred sixteen (66.3%) of the respondents were male. The majority of them 108(61.7%) were aged between 25 and 30 years and the mean age of respondents was 31.2years (SD= 6.5years). As many as 69(39.4%) of the respondents had 2 to 5 years of professional experience. Nearly half 92(52.6%) of them received recent training sessions on AMR and its containment.

Physicians were asked to indicate the situation(s) where they routinely wash their hands with soap and water or use a waterless alcohol-based hand antiseptic. Accordingly, majority of the physicians perform hand hygiene in the following situations; before and after having direct contact with patients 127(72.6%), after removing gloves, masks, white coats and leaving the clinic area 131(74.9%), before handling an invasive device for patient care regardless of whether or not gloves are used 112(64%), after contact with body fluids or excretions, mucous membranes or wound dressings 154(88%) and if moving from a contaminated body site to a clean body site during patient care 109(62.3%).

One hundred forty five (82.9%) physicians stated that they take AMR into consideration while deciding to prescribe an antibiotic and 151(86.3%) of them claimed that they adhere to national standard treatment guidelines for antimicrobial prescribing. Preference towards broader spectrum class of antibiotics over narrower ones had been reported by 108(61.7%) of the respondents. One hundred twelve (64%) respondents reported that their decision of which antibiotic to prescribe is influenced by local availability of antimicrobials in the hospital pharmacy.

Physicians implied situations when they would send a specimen to the microbiology laboratory for culture and sensitivity test. Accordingly, only 86(49.1%) of the physicians reported that they would send a specimen before initiating empiric antimicrobial therapy. In cases where treatment failure occurs with initially prescribed antibiotic regimens, 134(76.6%)

of the physicians reported that they would require culture and sensitivity test results before treatment revision.

Adhering to personal protective equipments during patient care had been reported among 111(63.4%) of the physicians. One hundred twenty four (70.9%) of the physicians claimed that they educate patients on suitable non-pharmacological alternatives for infection prevention and control and discouraged patient self-initiation of treatment with antimicrobials.

#### **6.1.4.2. Nurses' infection prevention and control practice**

A total of 420 nurses were surveyed and females accounted for 302(71.9%). The mean age of respondents was 29.3 years (SD= 7.9 years). One hundred thirty six (32.4%) respondents had under 2 years of professional experience. The majority of respondents 315(75%) were first degree holders. The remaining 102(24.3%) had diploma and only 7(1.7%) had MSc degree. Only 76(18%) of the respondents attended recent training on AMR and its containment.

Nurses were asked to indicate circumstance(s) where they would routinely perform hand hygiene. Accordingly, they performed hand hygiene practices in the following situations: before and after having direct contact with patients 365(86.9%), after removing gloves, masks, white coats or uniforms and leaving the clinic area 288(68.6%) and after contact with body fluids, excretions or wound dressings 294(70.0%). However, about 44.3% of the respondents claimed hand hygiene practice before handling an invasive device for patient care and 44.5% said that they wash their hand when moving from a contaminated body site to a clean body site during patient care.

Of all nurses (N=420), 268(63.8%) of them reported that they educate patients on the importance of infection prevention measures. The majority 281(66.9%) of them also reported that they promote awareness on strategies that reduce transmission of infection in the household or at community level. About 300(71.4%) of the respondents informed patients about health care seeking behaviour, 293(69.8%) of them informed patients about suitable non pharmacologic alternatives to antimicrobials for symptomatic relief and discouraged self-initiation of antimicrobial treatment. About 340(81%) of them reported wearing personal

protective equipments during patient care. Two hundred ninety four (70%) of the respondents performed appropriate sanitary practices in the hospital.

#### **6.1.4.3. Pharmacy professionals' practice in optimizing antimicrobial use**

A total of 31 pharmacy professionals were surveyed; their mean age was 26 years (SD= 2.8 years) of whom male respondents accounted for 19(61.3%) of the total sample. The majority 15(48.4%) of the respondents had 2 to 5 years of professional experience. As many as 21(67.7%) of the respondents graduated with BPharm degree and the remaining 10(32.3%) had diploma. Only 4(13%) of them attended training on AMR and its containment with in the past six months.

The majority of pharmacy professionals 26(83.9%) did not supply an updated list of available antimicrobials to prescribers working in their respective facilities. All respondents reported that no antimicrobial was dispensed without a prescription.

As few as 14(45.2%) of the respondents admitted providing information regarding rational prescribing and rational use of antimicrobials to prescribers and other fellow healthcare professionals. However, 28(90.3%) of them reported patient education regarding appropriate antimicrobial use and adherence to prescribed treatment regimens. Educating patients on avoiding self-medication practice with antimicrobials was reported by 30(96.8%) of the respondents. Performance of appropriate sanitary practices in the hospital had been reported in 17(54.8%) of the pharmacy professionals.

#### **6.1.4.4. Laboratory professionals' infection prevention and control practice**

A total of 41 laboratory professionals were surveyed. The mean age of the respondents was 29.5years (SD=5.5 years). The majority of respondents 28(68.3%) were male. As many as 17(41.5%) had 2 to 5years of professional experience. Most of the respondents 28(68.3%) had BSc degree, 8(19.5%) had diploma and 4(9.8%) had MSc degree. Only 6(14.6%) of the respondents attended training on AMR and its containment within the past six months.

Respondents were requested to select situation(s) where they routinely apply hand hygiene practice. All of the respondents claimed implementation of hand hygiene after specimen collection. Hand hygiene practice after removing gloves and when leaving the laboratory area had been reported in 38(92.7%) and 34(82.9%) of the respondents respectively.

Carrying out culture and sensitivity test had been reported in 32(78%) of the total respondents. All of the respondents reported that such tests are carried out only on physician request and notification of results is made as a paper report that is to be sent to the diagnosing physician. Summary reporting on antibiotic susceptibility patterns to the hospital had been claimed in 23(71.8%) of the respondents.

Respondents were asked to identify the situation(s) where they strictly adhere wearing personal protective equipments. Accordingly, all of the respondents confirmed application of protective barriers during blood drawing, specimen collection, laboratory processing and when there is direct contact with infectious wastes. Ensuring safe laboratory waste disposal system had been claimed in majority 36(87.8%) of the respondents.

#### **6.1.5. Knowledge-practice gap among different health professionals on AMR containment**

Healthcare professionals with good knowledge level on AMR containment had been selected from each professional category to identify potential gap between their knowledge level and reported AMR containment practice. In doing so, knowledge-practice gap had been identified among physicians and nurses that had good knowledge level regarding AMR containment.

Out of the physicians that had good knowledge level on AMR containment, 85(66.4%) reported preference of broad spectrum antibiotics than narrower ones during selection of antimicrobials for initiation of treatment with antimicrobials. In addition, only 54(42.2%) of the respondents with good knowledge level implied the use of laboratory findings before initiating empiric antibiotic therapy. Implementation of hand hygiene in all of the situations (where in all cases hand hygiene was mandatory) was reported in only 50(39.1%) of the respondents.

Among the nurses with good knowledge level on AMR containment, only 52(48.6%) reported implementation of hand hygiene practice in all of the specified situations where in all cases application of hand hygiene was a necessity.

### 6.1.6. Chi-square analysis

Chi-square analysis was used to determine association between respondents' demographic variables and their knowledge level on AMR containment. As depicted in table 3 below, a statistically significant association ( $p < 0.05$ ) was found between age group and knowledge level of healthcare professionals. Similarly, statistically significant association ( $p < 0.05$ ) had been identified between professional qualification and knowledge level of respondents. Chi-square analysis between training experience regarding AMR and its containment and knowledge level of healthcare professionals also revealed a statistically significant association ( $p < 0.05$ ).

Table 3: Association between respondents' demographic characteristics, training experience and knowledge level on AMR containment

Variables	Pearson Chi-square value	Degrees of freedom	P value
Age	19.01	10	< 0.05
Professional qualification	13.08	6	< 0.05
Training experience	15.99	2	< 0.05
Years of professional service	14.6	6	< 0.05

## **6.2. Qualitative Findings**

### **6.2.1. Findings from key informant interviews**

The key informant interview was held with a total of thirty eight key informants. Majority 20(52.6%) of the informants were in the age group 31 to 35 years. Twenty (52.6%) of the informants were male. They were purposively selected from different hospital departments. These include disease prevention and patient safety, clinical, pharmacy, microbiology laboratory, occupational health and environmental sanitation departments of the selected hospitals. In addition, infection prevention and control committee as well as DTC members of the selected hospitals were also incorporated in the key informant interview. All key informants were recruited purposively on the basis of their professional role and involvement in AMR containment particularly infection prevention and control practices.

#### **6.2.1.1. Infection prevention and control**

Majority of the key informants believed that AMR is a challenging issue in the healthcare system and further influencing their daily practice. The key informants revealed that there are infection prevention and control committees in their respective hospitals. In majority of the hospitals, the composition of the committee members had been organized according to the national infection prevention and patient safety guideline of the FMOH while in others the organization was in accordance with the Ethiopian Hospital Reform Implementation Guideline. In addition to the composition of the committee, in the majority of the hospitals, the committee's roles, duties and activities were designed based on the comprehensive FMOH national guideline. None of the hospital committees were familiar to FMHACA's national strategic interventions for AMR prevention and containment.

As explained by members of the infection prevention and control committee of the selected hospitals, the committee have the following roles: to establish hospital policies in line with the national guideline for infection prevention and control, to identify and investigate outbreaks of infections, to establish hospital policy for cleaning, sterilization and disinfection of medical equipments, to identify areas of intervention for the improvement of infection prevention and control practice, to provide infection prevention and control trainings for

hospital staff, to monitor the availability of infection prevention materials and to ensure safe hospital environment.

An informant who is a head of disease prevention and patient safety department explained the committee's role as follows,

*“Our goal is to create an infection-free and safer hospital environment; safe for practitioners, patients and other working staff.”*

It was noted that all infection prevention and control committee of the selected hospitals have fortnightly meeting schedule. But practically, majority of the key informants admitted that the meeting doesn't regularly convene as per the schedule. According to the key informants, work load and lack of commitment among the committee members account for meeting irregularities. Apart from that, activity of the committee was also limited in some of the hospitals.

One of the infection prevention and control committee focal person stated that,

*“It is hard to explain the activities handled by the committee because our infection control committee is on and off, it is not functional as there is no regular meeting and follow up.”*

Majority of the infection prevention and control committees of the selected hospitals give special concern for hand hygiene practice but very few have established a system for its implementation. In one of the selected hospitals, the KAP of healthcare professionals on hand hygiene practice had been assessed and hand hygiene project was initiated based on the assessment result. The project aimed at improving the hand hygiene practice of the healthcare professionals through hand hygiene awareness promotion and ensuring availability of alcohol based hand antiseptic preparation in all areas of the hospital where there is direct contact with patients. Preparation of the alcohol based antiseptic solution is formulated by the pharmacy department and is dispensed on weekly basis.

Head of the hospital's infection prevention and control committee explained that, *“Hand hygiene is a very crucial practice and we are handling the hand hygiene project as a campaign in this hospital to improve its implementation. We provide small group discussions with clinicians to enhance their awareness and adherence to the practice. We also evaluate the sensitizations and interventions. Now, I can tell we have achieved a very good compliance with improved awareness, attitude and implementation.”*

Regarding the implementation of employee health program on infection prevention, in almost all of the selected hospitals more emphasis is given for post-exposure prophylaxis management than immunization programs. All working staff particularly those in direct contact with patients (clinicians) and other healthcare professionals were informed about post-exposure prophylaxis service. There is a designated service in all of the selected hospitals for the attainment of such activity.

Concerning awareness campaigns or formal training sessions, most of the selected hospitals reported provision of trainings on AMR containment hospital practices mainly on infection prevention and control. The key informants explained that training programs mostly emphasize on infection prevention and control for those healthcare professionals who have direct interaction with patients during patient care. All key informants agreed on the importance of the training programs, but, very few of them claimed that post intervention evaluation on the trained practitioners is conducted.

In only one of the selected hospitals, orientation programs on infection prevention and control were maintained for new staff members especially for fresh graduates in clinical practice. According to the infection prevention and control focal person of the hospital, the program was designed to minimize the knowledge and practice gap among the healthcare professionals following the high turnover of trained professionals. Though rare, there were also infection prevention and control trainings or refreshment programs for supportive staffs such as cleaners, laundry staff and others.

One of the infection prevention and control focal person indicated that train the trainer programs were preferable.

*“In most of the cases, committee members are trained by external parties like FMOH and Non-Governmental Organizations (NGOs) then they train other trainees on what they had been trained. This type of training was found easier and more effective for our setting.”*

Isolation procedures are performed in all of the selected hospitals for patients with established infectious conditions that require additional precautions and prioritization. In the usual practice, head ward nurses are responsible for patient placement activities in a designated isolation room. In doing so, they admitted implementation of barrier precaution methods and allowing adequate air circulation in the isolation room by opening windows.

One of the head nurse explained the isolation procedure as follows,

*“Isolations of patients depend on the symptomatic presentation of patients if the patient is suspected for being possibly infectious like suspected TB patients then they will be placed in the isolation room before diagnosis and in other cases patients are isolated after completed diagnostic procedures.”*

Similar waste disposal system had been reported in all of the selected hospitals. According to the key informants, the waste disposal system is categorized into medical and general waste. Medical wastes are grouped as infectious and non-infectious. The waste containers vary with the type of waste to be segregated into it; sharp materials are discarded in a safety box, infectious wastes are disposed in a colored or labeled container and non-medical general wastes are collected and discarded separately in another container. Infectious wastes are incinerated whereas the non-contaminated general waste is sent off-site of the hospital environment along with the ash collected from the incinerated waste material.

#### **6.2.1.2. Control of antimicrobials use in the selected hospitals**

According to the key-informant interview held with the respective head pharmacists of the public hospitals, the following information had been obtained with regard to the control of antibiotic use in the hospitals.

All of the key-informants revealed that the lengthy and often limited pharmaceutical procurement system blocks the consistent availability of antimicrobials in the hospital. Irregular procurement procedure had been reported in all of the selected hospitals that led to inconsistent availability of antimicrobial medications. All of the key informants confirmed missing flexible procurement system to fulfill their requisitions and reliance on a single supplier: the pharmaceutical fund and supply agency. Stock out of antimicrobials is common as a result of the limitations in supply. One of the key informants stated that,

*“There is always a high demand we always have long lines of patients we never doubt the consumption but the problem is in ensuring the supply ..... the agency has to supply whatever quantity we need because they are responsible for it .....they should strictly address our demands.”*

As far as quantification and distribution of pharmaceuticals is concerned, in all of the cases respondents assured consumption-based quantification and distribution system to inpatient and outpatient pharmacies.

All of the key informants reported high prescription flow of combination and broadspectrum antibiotics as well as poly pharmacy of antibiotic medicines to the pharmacy. Though there was no feasible system in place that allows direct involvement of the pharmacy professionals in optimizing antimicrobial therapy during the past, the recently introduced clinical pharmacy practice ensures the most convenient way of addressing rational prescribing and use of antimicrobials. One of the key informants explained that,

*“Clinical pharmacists are always there at the point of decision making of which antibiotics are to be prescribed. Infact, we want them to involve from drug selection to dispensing process, that way we can address rational prescribing and use of antibiotics. And that is what they are doing right now; the feedback we get from physicians is also supportive and encouraging.”*

In only one of the selected hospitals, Antibiotic Stewardship Programme (ASP) is already designed and included as a short term immediate plan for implementation. DTC are established in majority of the assessed facilities but functional in only some of the hospitals.

In the hospitals where the committee is functional, its major duties include designing, framing and revising the hospitals drug list. Moreover, the committee works in promoting rational prescribing and drug use. No implementation of antibiotic rotation system and drug utilization reporting is done in any of the selected hospital pharmacies. In replacement for the rotation system, the key-informants explained that revision of the hospital drug list considers the add in and out of pharmaceuticals to and from the list.

One of the head pharmacists explained that,

*“So far, no drug utilization reporting had been employed but very soon we are going to launch a new program called Auditable Pharmacy Transaction System in the pharmacy system that had been introduced by MSH in collaboration with Addis Ababa Regional Health Bureau.” The respondent further explained that, “this new system is in progress and will assist daily reporting of dispensed medications, monitoring the prescribing pattern in the hospital and monitoring daily activities.”*

#### **6.2.1.3. Culture and sensitivity test**

The key informants for this topic were microbiologists, head of laboratory department and infectious disease specialists in hospitals where culture and antimicrobial susceptibility tests are performed.

According to the key informants, mostly culture and sensitivity tests are employed on the basis of physician request. Results are then sent back to the requesting physicians and will also be documented in the laboratory registration manual. Summary reports are made in majority of the hospitals and monthly reporting is commonly employed.

Poor utilization of culture and sensitivity test results and reports had been explained by the majority of the key informants. One of the key informants who is a microbiologist explained that,

*“..... we do the culture test, sensitivity test we identify resistant strains but nobody cares about the result we do notifications to the hospital nobody asks anything no feedback on the reports”* the respondent further elaborated the situation when asked about the utilization of reports by the hospitals infection prevention and control committee, *“the infection control committee never came to us never inquired anything from our department they have a very poor interaction with our department.”*

All key informant physicians who were infectious disease specialists reported that results from culture and sensitivity had an important influence on their choice of antibiotic. However, most had complaints on the validity and reliability of the laboratory findings.

One of the key informants explained that,

*“Sometimes it is better to prescribe broader spectrum antibiotics without laboratory confirmation because we mostly face highly symptomatic patients with false negative results ... I personally employ my experience when I face such cases I have doubts on the laboratory results especially when reported negative.”*

#### **6.2.1.4. Surveillance of new infections and AMR**

In majority of the hospitals, new tracking of infection is inspected regularly. Mostly, weekly diagnosed conditions are assessed and report will be made. Those facilities under the administration of AACAHB report weekly summaries of diagnosed clinical conditions to the AACAHB. As explained by the key-informants, this is done to identify and investigate outbreaks of infections.

Though it is a common practice to inspect the hospital environment for newly occurring clinical cases in almost all of the assessed hospitals, only two of the selected hospitals assured the presence of an established system in place for the surveillance of AMR.

## **6.2.2. Facility assessment on AMR containment practice**

The selected hospitals had been assessed through observation with a special emphasis towards infection prevention and control in the hospital environment. In almost all of the selected hospitals, similarities had been noted out with regard to the structural non-conduciveness of the hospital environment for the implementation of infection prevention and control.

### **6.2.2.1. Visual alerts**

Visual alerts such as posters were placed in all of the assessed hospitals denoting alert messages to the patients and attendants. At the time of observation, visual alerts peculiar to respiratory symptoms had been observed in only three of the assessed hospitals. Visual alerts informing patients, clients or healthcare professionals about critical infection prevention practices (such as hand washing, injection safety, use of gloves during invasive procedures) had been observed in outpatient facilities, wards, emergency service area, laboratory areas of some of the assessed hospitals. Visual signs to alert patients or clients about restricted or risky areas (in relation to infection prevention and control) had been observed in limited areas in all of the assessed health facilities. Mostly restricted hospital areas include laboratory and central sterilization department and operation theaters.

### **6.2.2.2. Patients triages and isolation rooms**

Regarding patients triages, patient overcrowding was common in all of the observed hospitals during the observation period. Structurally, the patient triages were narrower than they should be when compared to the patient flow to the institutions. A designated waiting area for patients presenting with respiratory infectious symptoms had been observed in one of the selected hospitals. However, the waiting area was not hygienically safe and there were no hand hygiene facilities in the designated area for patients and visitors. In some of the hospitals, designated temporary patient isolation rooms were available in closer proximity with the patient triages of outpatient facilities.

### **6.2.2.3. Ventilation systems and barrier precautions**

At the time of observation, in all of the observed hospitals natural ventilation system was employed where windows were open. However, due to the high patient overcrowding there was poor air circulation in patient triages, wards and examination rooms. No mechanical ventilation system had been observed. It was observed that in most of the settings, sitting arrangement of health care professionals and patient was arranged in parallel to the wind direction.

In almost all of the observed hospitals, healthcare professionals wore contact precaution materials (gloves and gowns). In one of the selected hospitals, the professionals in addition to contact precaution materials wore other personal protective equipments such as face shields like N95 face masks. Implementation of barrier precaution for patients had also been observed in the same institution specifically for patients and attendants of a designated ward where the likelihood of infection transmission is expected to be higher. Face masks had been offered for the patients and attendants with education.

### **6.2.2.4. Environment inspection and waste management**

Overall, there was poor availability and accessibility of dedicated hand hygiene facilities. There was limited hand washing sinks even for the professionals with inconsistent water supply. At the time of observation, no adjacent soap dispenser, disposable towels was observed in most of the selected hospitals.

Separate isolation rooms were available in all of the selected hospitals for diagnostically confirmed contagious or infectious patients. But, in emergency wards simple curtains were used to isolate patients that could be contagious. High risk of infection transmission had been observed in such wards of all assessed hospitals. In all of the selected hospitals, separate rest rooms were available for staff and patients but with poor sanitation.

All selected hospitals followed similar waste disposal system where two disposal containers had been placed in patient wards, triages and other hospital surroundings usually being colored and labeled. The wastes were disposed as infectious and non-infectious waste. In

some of the hospitals, detailed list of infectious wastes were posted as visual alerts. Those wastes considered as infectious were the ones like dressings and waste dripping with blood. Sharp materials and needles were separately discarded in a safety box in all of the observed settings.

Relatively, there were sufficient dustbins available in the hospital environment that avoided littering of waste in the ground. However, sanitation of hospital grounds (floor) was not ensured in almost all of the assessed hospitals although claimed to be cleaned twice daily. Cleaning staff did wear personal protective equipments such as utility gloves and plastic apron but no face mask while cleaning the hospital.

#### **6.2.2.5. Microbiology laboratory**

Bio-safety cabinets were found only in all of the hospital laboratories conducting culture and sensitivity testing. There was manual registration book for recording of test results in all of the observed hospital laboratories. But, reporting documents had been found in only some of the hospital laboratories.

Barrier precaution facilities were available in all laboratories at the time of observation. Hand hygiene facilities were also accessible along with hand washing materials in most of the laboratories but in only some cases inadequate hand hygiene facilities had been noted when compared to the number of professionals. Refrigerator was available and functional in all of the observed hospital laboratories and no food or drink had been stored in it. Visual posters had been displayed alerting professionals to wear barrier precautions, not to store food or drink in refrigerators and for patients and clients restriction into the laboratory area.

#### **6.2.2.6. Pharmacy**

In majority of the observed hospital pharmacies, there was no dedicated hand washing facilities. Refrigerators were available and functional and no food or drink was stored in it at the time of observation.

### **6.3. Factors influencing the AMR containment practice**

Factors that may potentially influence the AMR containment practice in the selected hospitals had been identified from the key-informant interview held with the professionals from various professional categories and also from the observation made by the principal investigator. Accordingly, the identified factors are presented as promoting and limiting factors for the hospitals AMR containment practice. The promoting factors are those contributing for better implementations of AMR containment practice in the facilities whereas the limiting factors are barriers that hinder such practice.

#### **6.3.1. Promoting factors**

- Collaboration of external funders (NGOs) with the hospitals
- Involvement and assistance of FMoH and AACAHB on infection prevention and control
- Organized trainings, small group discussions, open lectures, workshops, orientation and awareness promotion programs
- Implementations of short-term project based interventions
- Evaluations; FMoH periodic evaluation, post-intervention evaluations
- Staff motivation
- Recognition of hospital department's professional service especially for their contributions towards infection prevention and control

#### **6.3.2. Limiting factors**

- Financial constraints
- Inconsistent availability of antimicrobials
  - Dependent and lengthy pharmaceutical procurement system
- Inadequate microbiology laboratory service
  - Inadequate supply of reagents and other laboratory chemicals
  - Utilization of old laboratory equipments
  - Work overload
  - Insufficient man power

- Unsatisfactory infection prevention and control practice in the hospital environment
  - Inadequate availability of infection prevention and control materials
  - Inadequate supply of hygiene and sanitary materials
  - Inadequate supply of barrier precautions
  - Work overload
  - High man power turnover (trained staff turnover)
  - Negligence
  - Infrastructural limitations for isolation procedures
  - Poor commitment of healthcare professionals
- Limited utilization of laboratory services for diagnosis of infectious etiologies
- Weak functioning of established hospital committees
  - Weak functioning of the hospital infection prevention and control committee
  - Weak functioning of the hospital DTC
- Poor communication
  - Between established committees and hospital departments
  - Between established committees and hospital administration
  - Between the healthcare professionals in different specialties
- Knowledge gap
  - Among healthcare professionals
  - Between healthcare professionals and managerial (administrative) staff
- Limited training provision experience
  - Limited to clinicians and few other healthcare staff
  - Dependent on external parties (FMoH or NGOs)
- Poor follow-up
  - Poor post intervention follow up
  - Poor post training follow up for implementation
- Poor surveillance of new infections and AMR
- Insufficient qualified human resource
  - Insufficient trained healthcare professionals
  - Insufficient sanitarians, occupational health officers and other infection prevention and control personnels

## 7. Discussion

The study aimed to provide a full picture of AMR containment practices in the selected hospitals through assessing the KAP of healthcare professionals towards AMR and its containment, describing the general AMR containment practice in the hospital settings and identifying potential factors influencing the containment practice in the facilities. Majority of the healthcare professionals were knowledgeable regarding conditions or factors that promote the spread of AMR in hospital settings. But, overall results of the study revealed that as many as 321(48.1%) of the respondents had poor knowledge level on AMR containment.

Chi-square analysis revealed statistically significant association ( $p < 0.05$ ) between knowledge level on AMR containment practices and the professional qualification of respondents. The proximity of health professionals for obtaining information regarding AMR containment through training sessions, lectures, seminars or workshops coupled with their diversified routine practical exposure might have prominently accounted for the existing variations and knowledge gap among the professionals in different professional categories.

Statistically significant association ( $p < 0.05$ ) was found between knowledge level of health professionals on AMR containment practices with the variables age and professional experience. Increment in seniority of professionals largely favors acquisition of broader skills and professional expertise that might attribute for the attainment of better knowledge level on AMR containment.

Statistically significant association ( $p < 0.05$ ) had been identified between recent training experience and knowledge level of healthcare professionals. Those who attended recent training on AMR and its containment were more knowledgeable than those who didn't attend such training sessions.

Education for health care professionals is recommended to attain AMR containment. Intervention based educational models, small group discussions, encouraging practical reflection and use of feedback are essential parameters to accomplish behaviour change among the professionals (WHO, 2001). In the current study, the apparent lack of recent training experience was supported by the findings of lower knowledge level. Hence, ongoing educational efforts regarding AMR containment must be incorporated as an important measure in helping curtail the problem of AMR in hospital settings.

In the current study, majority of the healthcare professionals (82.2%) had awareness on incorporation of hand hygiene for AMR containment in hospital settings. Regardless of the knowledge level, the reported hand hygiene practice of physicians and nurses was not satisfactory. According to a study conducted to assess physicians' knowledge and perception of AMR in Khartoum state hospital settings, inadequate hand-washing was identified and may reflect lack of awareness of the effectiveness of this simple, yet underused practice and the laxity of hand hygiene washing and disinfection by Sudanese health care workers (Kheder, 2013). Inadequacies in water and hand hygiene materials supply, negligence, workload and undermined awareness and attitude of health care professionals towards hand hygiene were the major reasons limiting the hand hygiene practice of the professionals practicing in the assessed hospitals.

The current study revealed that in one of the assessed hospitals, hand hygiene is given special emphasis in infection prevention and control and efforts had been made to boost the awareness of the professionals, improve their attitude and practice on hand hygiene through intervention based projects and small group discussions. Same progress should be established and must be applicable in the other settings to ensure the implementation of infection prevention and control. Achieving staff compliance with hand hygiene practice is a significant improvement that hospitals should experience towards infection prevention and control.

According to a study conducted to assess nurse's infection prevention practice, with regards to hand hygiene and use of personal protective equipments, findings of the study suggested that although knowledge of these practices was poor, application of these skills was good (Slyne *et al.*, 2012). In this study, it was shown that application of barrier precautions was good unlike the poor knowledge level in that regard. The healthcare professionals in general

had lower knowledge (57.1%) and amongst the nurses included in the survey only (49%) were knowledgeable on the implementation of barrier precautions and isolation procedures for AMR containment in hospital settings. Contrasting with poor knowledge level, majority (81%) of nurses reported wearing personal protective equipments in their routine practice. It is, therefore, essential to promote the awareness of health care professionals regarding use of these barriers in order to improve their adherence.

According to a study conducted in Lima, Peru to assess the knowledge, attitudes and practice about AMR and prescribing among physicians in a hospital setting, almost all participants considered that AMR is a problem in their own practice. The vast majority of participants strongly agreed and agreed upon the perception of overuse of antimicrobials in hospitals, the development of antimicrobial prescribing educational programs and considering AMR rates when prescribing antimicrobials. Most of them confirmed that a local antimicrobial guideline would be more useful than an international one (Garcia *et al.*, 2011).

Another study conducted to assess the knowledge, attitude and belief of house staff physicians concerning antimicrobial use and AMR also reported that majority of the respondents agreed that antimicrobials are overused at their own hospital and AMR should be considered when prescribing antimicrobials for an individual patient (Srinivasan *et al.*, 2004). Similar results had been obtained in the current study where the majority of physicians agreed and strongly agreed that AMR is a significant problem, antimicrobials are overused in their hospital and AMR should always be considered when antibiotics are prescribed. However, disagreement upon the usefulness of locally developed hospital formularies had been notified among the majority of the physicians. This attitude of physicians could be related to their awareness level on the role of hospital drug formularies in AMR control. Not only physicians, but also majority of the surveyed health care professionals had inadequate knowledge on the application of hospital drug formularies in AMR containment.

Preference on initiation of antimicrobial therapy with broadspectrum antibiotics instead of narrower ones had been reported by majority of the physicians encountered in this study. Influence of pharmaceutical companies is very well recognized to have effect in the prescribing attitude and behavior of prescribers (Kheder, 2013). Majority of the healthcare

professionals agreed and strongly agreed with respect to the influence of pharmaceutical representatives on the prescriber's choice of antibiotic towards broad-spectrum antibiotics.

Lack of prescriber's knowledge regarding optimal diagnostic approaches or lack of opportunity for patient follow up, insufficient training in infectious diseases and antibiotic treatment also promote the use of broad spectrum antibiotics (Bisht *et al.*, 2009). In this study, similar reasons had been mentioned together with the following explanations as attributing factors for choosing broader spectrum antibiotics: undermined utilization of laboratory confirmatory tests, high rates of treatment failure with narrow spectrum antibiotics and low adherence on standard treatment guidelines and locally developed formularies for prescribing antimicrobials.

According to a study conducted in Lesotho to assess healthcare provider's attitudes and perceptions in infection diagnosis and antibiotic prescribing, under-use of laboratory findings by prescribers in infection diagnosis and antibiotic treatments had been identified which contributes to inappropriate antibiotic prescribing practice (Adorka *et al.*, 2013). Similar result had been obtained in this study where physicians specified the situations where they would send a specimen to the microbiology laboratory for culture and sensitivity test and only (49.1%) send a specimen before initiating empiric antibiotic therapy and (76.6%) of the prescribers reported the requisition of culture and sensitivity testing to allow revision or replacement of the antibiotic therapy. In addition, key-informant physicians explained on prescribing antibiotics without adequately establishing the presence and characteristics of microbial pathogens as etiologies of clinical cases.

Inadequate laboratory capacity is one of the limiting factors hindering the ability to rapidly detect resistant microorganisms for prompt treatment and control measures (Leung *et al.*, 2011). In many African countries, health facilities and laboratories in particular are reportedly faced with significant infrastructural challenges (Kimang'a, 2012). A study conducted in Kenya to assess the knowledge, attitude and perceptions concerning AMR and antibiotic use practice among hospital staff reported that regarding laboratory service, government hospital staff ranked work overload and inconsistent supply of reagents as significant challenges in their routine practice (EPN, 2010). In the current study, such ranked constraints in addition to high patient overload, delays in receipt of laboratory results and poor validity of reported test

results were also a common problem in the assessed hospital settings contributing for the under-utilization of the laboratory services by physicians. Hence, these findings direct the need for strengthening the laboratory service and prescriber education on accurate infection diagnosis using laboratory confirmatory tests in order to reverse the common practice of irrational antibiotic prescribing.

Hospital physicians often prescribe antibiotics excessively and inappropriately. In poor countries, where many of the second or third line therapies for drug resistant infections are not available, making the potential of resistance to first line antibiotics is considerably greater (Bisht *et al.*, 2009). An estimated 50% of antibiotic use in hospitals is deemed inappropriate and consumption of antibiotics correlates directly with the frequency of resistance. Tackling resistance then requires better use of antibiotics (Merrett, 2013). The current study implied poor control of antibiotic use in the selected hospitals despite the existing AMR problem associated with irrational prescribing practice and use of antimicrobials. There was much less effort in all of the selected hospitals in undergoing interventions, such as antibiotic restriction and cycling interventions, that restrict physician's inadvertent prescribing practice.

Availability of institution specific drug lists in some of the selected hospitals is an encouraging practice as the adoption of local drug lists would assist rational prescribing practice of the physicians. Though treatment guidelines as well as drug lists had been developed in some of the settings, its distribution wasn't fully achieved and poor effort in promoting adherence of prescribing professionals to the guidelines had been explained. The role of hospital formularies (hospital drug lists) in AMR containment was not also well understood in the majority of the healthcare professionals (65.5%). Besides, poor knowledge of healthcare professionals had been identified concerning control of antimicrobial use in hospitals (47.4%). It is, therefore, essential to promote awareness among the healthcare professionals regarding judicious antibiotic utilization and harmonize the overall control of antibiotic use in hospital settings through antibiotic cycling and restriction.

In many developing countries, the health care facilities lack effective ASP (Carlet *et al.*, 2012). In the current study, ASP despite being very important for AMR containment in hospital settings, it was introduced and incorporated as short term immediate plan in only one of the assessed hospitals. Implementation of ASP will attain three major goals. These include: to

work with health care practitioners to help each patient receive the most appropriate antimicrobial with the correct dose and duration, to prevent antimicrobial overuse, misuse and abuse and to minimize the development of resistance (Doron and Davidson, 2011). ASP should then be given major concern and should be applicable in all of the settings.

A pharmacist plays an important role in reducing AMR by counseling each individual patient on appropriate use of antibiotics, preparing local prescribing guidelines for antibiotics, promoting good prescribing practice, monitoring antibiotic use in the hospital and providing educational and training program for other fellow healthcare professionals (Bisht *et al.*, 2009). The current study revealed that such activities aren't satisfactorily applicable by the pharmacy professionals for reasons associated with unfavorable conditions of their professional scope limiting their clinical interaction with fellow professionals.

The recently modified curriculum, clinical pharmacy practice, is a very essential and most effective way of addressing rational prescribing and use of antimicrobials where the pharmacists act as a bridge between the physicians and patients so as to assist and ensure the selection of appropriate antimicrobial regimens. The clinical pharmacy practice is associated with more appropriate antibiotic prescribing practice, improved patient outcomes and minimized resistance emergence. It is also a key practice for the implementation of ASP. The engagement of clinical pharmacists in the hospital should then be encouraged as it prominently activates the pharmacist's role in AMR containment.

Patients should have a basic understanding of resistance and the judicious use of antibiotics. Knowledge of appropriate use can dramatically reduce abuse (Merrett, 2013). In the current study, majority of the healthcare professionals reported patient education on suitable non-pharmacological alternatives for infection prevention and control and discourage patient self-initiation of treatment with antimicrobials, measures that reduce transmission of infection in the household or community, appropriate and informed healthcare seeking behaviour, appropriate antimicrobial use and adherence to prescribed treatment regimens and on avoiding self-medication practice with antimicrobials. Thus, such practices of the healthcare professionals should be encouraged as they are mandatory to allow judicious use of antimicrobials.

The current study revealed that majority of the assessed hospitals stress on investigation of outbreaks of new infections in their facility but very few of the hospitals reported surveillance of AMR. According to WHO, surveillance of AMR is essential for providing information on the magnitude and trends in resistance and for monitoring the effect of interventions. The local surveillance data should be used to guide clinical management and update treatment guidelines, educate prescribers and guide infection control policies (WHO, 2001). Thus, AMR surveillance should be incorporated in all of the hospitals so as to assist the follow up of hospital's infection prevention and control practice.

The current study elucidated the incorporation of FMOH national guideline as an infection prevention and control policy in most of the assessed facilities. Since the key national strategies for AMR prevention and containment had been enclosed under the FMOH's comprehensive guideline for hospital settings, effective implementation of the guideline through coordinated and monitored activities will by far address the national strategies.

Successful AMR containment strategies involve the collaboration of several groups including prescribers, patients, pharmacists, the general public and government. Surveillance, education, infection control, limiting and reducing unnecessary antimicrobial use remain the cornerstone of the overall strategy to combat AMR in health care institutions. In hospitals, it is crucial to develop integrated approaches to improve the use of antimicrobials and to reduce the incidence and spread of hospital-acquired infections. This will require training of key individuals and allocation of resources for effective surveillance and infection control (Gin and Zhanel, 2001; WHO, 2001). The current study revealed financial constraints and inadequate supply as major factors limiting the infection prevention and control activities. Poor communication and interaction of the infection prevention and control committee had also been identified as the other major limiting factor. It is, therefore, less likely for multidisciplinary coordination to exist in the settings unless these gaps are filled.

Hence, ensuring adequate and consistent budget allocation for infection prevention and control activities should be considered in all of the assessed settings. Harmonizing hospitals infection prevention and control committee with all the relevant departments is essential to address an integrated AMR containment practices in the hospitals. In very few of the assessed hospitals, active communication of such committee had been noted. It is, therefore, a

requirement for all hospital infection prevention and control committees to build and maintain strong communication channels with all important hospital departments mainly microbiology, clinical and pharmacy departments in order to achieve the implementation of AMR containment practices in the settings. Establishment of such an organized system is not only a requirement but a necessity for allowing and guaranteeing the implementation of AMR containment practices in the hospital settings.

Achieving AMR containment in hospital settings is a great success in tackling the problem of AMR but it needs to be supplemented by other core public health activities that had to be managed at the community level starting from infection prevention to rational use of antimicrobials. Addressing the toll of AMR then stretches out from the hospital settings to the whole population so that its containment should be encompassed as a national package.

The health policy of the Federal Democratic Republic of Ethiopia has given due emphasis to promotive and preventive interventions. Consequently, the health promotion and disease prevention general directorate has been established and integrated four major health programmes (FMoH, 2014). These are:

- Communicable disease prevention and control
- Hygiene and sanitation
- Information, education, communication and advocacy
- Maternal and child health

Addressing these health programmes along with implementations of AMR containment strategies in hospital settings remain being the key measures for successful containment of AMR.

## **8. Strengths and Limitations of the study**

### **8.1. Strengths**

- The study objective tried to address new issue
- The study employed mixed method approaches
- The study employed triangulation
- The study incorporated large sample size and achieved high response rate

### **8.2. Limitations**

- Use of similar knowledge and attitude assessment questions for respondents with different professional qualification
- Language barrier could have affected the response of the respondents
- Social desirability bias might have been encountered on the responses for the practice section
- Respondents might have been reluctant to complete the questionnaires due to work load
- Unavailability of similar published studies in Ethiopia made the discussion less comprehensive

## **9. Conclusion**

The study revealed poor knowledge level regarding AMR containment among the majority of health care professionals. Knowledge gap was identified among the different professional categories where physicians achieved the largest proportions of good knowledge level on AMR containment. Moreover, the significant impact of training experience on the knowledge of healthcare professionals had been pointed out supported by the association of good knowledge level on AMR containment with recent training experience.

The study also revealed inadequate implementation of AMR containment practices in the majority of the selected hospitals. Poor infection prevention and control practices, inadequate antimicrobial use control, inadequate surveillance activities, structural non-conduciveness of the hospital environment as well as infrastructural limitations mainly account as drawbacks limiting the AMR containment practices in the assessed facilities. Established hospitals' infection prevention and control committees and DTC weren't fully functional and had loose interaction with the key hospital departments where maintaining closer contact and follow-up was mandatory for successful implementation of AMR containment practices in the hospital.

## **10. Recommendations**

Based on the study findings, the following recommendations are forwarded,

### **For FMoH and AACAHB,**

- Periodic evaluation programmes should be strengthened and post-evaluation feedbacks should be communicated to the hospitals

### **For the hospitals' administration,**

- The hospitals should ensure adequate and consistent availability of antimicrobial medications, infection prevention and control materials, laboratory supplies and all other inputs that are essential for implementation of AMR containment practices.
- The hospitals should perform infrastructural modifications to improve the availability and accessibility of adequate isolation rooms, hand hygiene facilities as well as to create structurally conducive environment for infection prevention and control.

### **For hospital's infection prevention and control committees and DTC,**

- Functionality of the established committees should be ensured and their activities should be monitored.
- ASP should be introduced and incorporated in the committee's plan and its implementation should be emphasized.
- Training programs should be organized to promote awareness of healthcare professionals. Post training or post intervention evaluations should be done following trainings and interventions.
- The committee should establish active communication with the relevant hospital departments that are key for AMR containment implementation.

### **For the healthcare professionals,**

- Patient education on the importance of visiting health facilities for health problems, the risk of self-initiation of antimicrobial treatment and rational use of antimicrobials should be strengthened.

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Annex I: Self-administered questionnaires for the KAP survey

**ADDIS ABABA UNIVERSITY**  
**COLLEGE OF HEALTH SCIENCES**  
**SCHOOL OF PHARMACY**  
**DEPARTMENT OF PHARMACEUTICS AND SOCIAL PHARMACY**

The purpose of this study is to assess the knowledge, attitude and practice of health care professionals concerning antimicrobial resistance and antimicrobial resistance containment in selected public hospitals Addis Ababa, Ethiopia. Your participation is essential as your feedback is vital for the successful completion of the study.

**Section I. Demographic information**

1. Age in years: \_\_\_\_\_
2. Gender      Male  Female
3. Professional experience \_\_\_\_\_ in years   or \_\_\_\_\_ in months

**For Physicians**

4. What is the highest education level you completed?  
 General practitioner      Specialization      Other: \_\_\_\_\_
5. Have you received trainings related to AMR, infection control, antibiotic prescribing and use with in the past six months?    Yes      No

**For Nurses and Laboratory professionals**

4. What is the highest academic level you completed?  
 MSc Degree    BSc Degree      Diploma    Other: \_\_\_\_\_
5. Did you receive training related to AMR, infection prevention and control and antibiotic use with in the past six months?    Yes      No

**For Pharmacy professionals**

4. What is the highest education level you completed?  
 MSc      BPharm      Diploma    Other: \_\_\_\_\_
5. Did you receive training related to AMR, infection prevention and control and antibiotic use with in the past six months?    Yes      No

**Section II: Knowledge assessment section**

Please tick (x) in the space provided under “True” if your response is True or under “False” if your response is False

No.	Knowledge questions	Response	
		True	False
1	Antimicrobial resistance is directly linked to irrational prescribing practice and irrational use of antimicrobial agents.		
2	Empiric antimicrobial therapy aggravates the problem of Antimicrobial resistance		
3	The duration of patient exposure to antimicrobials influences the likelihood of colonization with resistant microorganisms		
4	The problem of Antimicrobial resistance doesn't depend on the consistency of antimicrobial supply		
5	Availability of hospital formularies in the hospital doesn't have a role in Antimicrobial resistance containment		
6	Patient overcrowding in hospital wards contributes to the spread of infectious diseases		
7	Air circulation system in hospital settings doesn't affect the spread of infections and antimicrobial resistance		

8. Which of the following activity/ activities should be encountered for the implementation of AMR containment in hospital settings? (**You can select more than one alternative**)

- A. Control of antimicrobial use and antimicrobial restriction
- B. Use of aseptic techniques for medical and nursing procedures
- C. Using laboratory findings in diagnosis of infectious etiologies
- D. Adequate sterilization and disinfection of medical equipments
- E. Surveillance of new infections and antimicrobial resistance
- F. Implementation of barrier precautions and isolation procedures
- G. Hand hygiene
- H. Sanitary control of the hospital environment

**Section III: Attitude assessment section Please tick (x) for 1: Strongly agree, 2: Agree, 3: Neither, 4: Disagree, 5: Strongly disagree**

No.	Attitudes of health care professionals	1 SA	2 A	3 N	4 DA	5 SDA
1	I think antimicrobials are overused in this hospital					
2	I think antimicrobial resistance is a significant problem in this hospital					
3	I think there is low level of awareness among health professionals concerning antimicrobial resistance and its containment					
4	I think the availability of drugs in the hospital affects the selection of antimicrobials					
5	I would like the organization of trainings and educational programs on antibiotics					
6	I think implementation of infection control practices in this hospital is not satisfactory					
7	General knowledge on antimicrobial resistance should be considered when antibiotics are prescribed to an individual patient					
8	I think pharmaceutical representatives influence prescriber's choice of antibiotic					
9	I think health care professionals working in this hospital are knowledgeable on antimicrobial resistance and its containment					
10	I think my interaction with colleagues and/or consultants influence my choice of antibiotic					
11	In my attitude, locally developed drug formularies would be more useful than national guidelines					
12	I think poor hand hygiene practices are common among health workers					
13	I think the availability of infection control facilities in this hospital is poor					
14	I think the hospital doesn't carry out adequate infection prevention and control practices					

**Section IV: Practice Assessment**

**I. Physicians' practice assessment**

Please tick (x) in the space provided under “Yes” if your response is Yes or under “No” if your response is No

No	Practice Assessment Questions	Response	
		Yes	No
1.	While deciding to prescribe an antimicrobial, do you take antimicrobial resistance into consideration?		
2.	Do you adhere to standard treatment guidelines for prescribing antimicrobials?		
3.	Do you prefer to prescribe broadspectrum antibiotics instead of narrower ones?		
4.	Do you wear personal protective equipments during patient care?		
5.	When you decide which antibiotic to use, is your election more affected by the availability of the drug than the true cause of the infection?		
6.	Do you educate patients on suitable non pharmacological alternatives for infection prevention and control and discourage patient self-initiation of treatment with antimicrobials?		

7. Please indicate (encircle) the situation (s) where you send a specimen to the microbiology laboratory for culture and sensitivity test

- A. Before initiating empiric antimicrobial therapy
- B. In cases of treatment failure with initially prescribed regimens

8. In which of the following situation (s) do you routinely wash your hands with soap and water or a waterless alcohol-based hand antiseptic?

- A. Before and after having direct contact with patients
- B. After removing gloves, masks, uniform, white coats and when leaving the clinic area
- C. Before handling an invasive device for patient care regardless of whether or not gloves are used
- D. After contact with body fluids or excretions or wound dressings
- E. If moving from a contaminated body site to a clean body site during patient care

## II. Nurses' practice assessment

Please tick (x) in the space provided under “Yes” if your response is Yes or under “No” if your response is No

No.	Questions	Response	
		Yes	No
1.	Do you educate patients on the importance of measures to prevent infection, such as immunization?		
2.	Do you promote awareness on patients regarding measures that reduce transmission of infection in the household or community?		
3.	Do you encourage appropriate and informed health care seeking behaviour?		
4.	Do you educate patients on suitable alternatives to antimicrobials for relief of symptoms and discourage patient self-initiation of treatment with antimicrobials?		
5.	Do you perform appropriate sanitary practices and waste management in the hospital?		
6.	Do you wear personal protective equipments during patient care?		

7. In which of the following situation (s) do you routinely wash your hands with soap and water or a waterless alcohol-based hand antiseptic?

- A. Before and after having direct contact with patients
- B. After removing gloves, masks, uniform, white coats and when leaving the clinic area.
- C. Before handling an invasive device for patient care regardless of whether or not gloves are used
- D. After contact with body fluids or excretions or wound dressings
- E. If moving from a contaminated body site to a clean body site during patient care

### III. Pharmacy professionals' practice assessment

Please tick (x) in the space provided under "Yes" if your response is Yes or under "No" if your response is No

No.	Questions	Response	
		Yes	No
1.	Do you supply an updated list of available antimicrobials to prescribers?		
2.	Do you dispense antimicrobials without prescription?		
3.	Do you participate in optimizing antimicrobial therapy to promote compliance of patients to antimicrobials?		
4.	Do you perform appropriate sanitary practices and waste management in the hospital?		
5.	Do you provide information regarding rational prescribing and use of antimicrobials to prescribers and other fellow health care professionals?		
6.	Do you inform/educate patients about appropriate antimicrobial use and the importance of adherence to prescribed treatments?		
7.	Do you educate patients on avoiding self-medication practice with antimicrobials?		

#### **IV. Laboratory professionals' practice assessment**

1. Do you perform culture and sensitivity tests in this facility?  Yes  No

If yes, please proceed to question number 2

If no, please go to question number 5

2. Under what circumstances is culture and sensitivity test performed?

A. Only on physician request    B. Routinely    Other: please specify \_\_\_\_\_

3. How do you notify physicians that a blood culture is positive? (Mark the usual method)

A. No notification is sent to physicians

B. Paper report sent to the ward or unit

C. Telephone call directly to the physician

4. Do you prepare summary reports of antibiotic susceptibility patterns for the hospital?

A. Yes            B. No

5. Do you ensure separate disposal of infectious and non-infectious waste?

A. Yes            B. No

6. Please encircle the situation(s) where you routinely perform hand hygiene (hand washing)

A. After specimen collection

B. After removing gloves

C. Leaving the laboratory area

7. Please encircle the situation(s) where you strictly adhere on wearing protective barriers

A. During specimen collection

B. During blood drawing

C. During laboratory processing

D. When there is direct contact with infectious wastes

## Annex II: Semi-structured Interview Guides for Key Informant Interviews

### Demographic information for all key informants

1. Age in years: \_\_\_\_\_
2. Gender       Male  Female
3. Total years of professional experience \_\_\_\_\_ in years
4. What is the highest education level you completed?
5. What is your professional title?

### I. Interview guide for infection prevention and control committee members

1. Do you face any challenge in your daily practice as a result of AMR?
2. Do you have an infection prevention and control hospital policy?  
Prompts: how did you adopt the policy (the reference)? Is there an involvement of external bodies for the development and implementation of the policy? Are you familiar with FMOH and FMHACA's national guideline?
3. Regarding the infection prevention and control committee, how was the composition of the committee organized?  
Prompts: What was the reference? Is there a regular meeting? How often does it convene? What is the major role of the committee? Does the committee work with the hospital administration and with the various hospital departments (mainly with clinical, pharmacy and microbiology departments)?
4. What strategy do you currently have to reduce the transmission and promote the control of infections in the hospital?  
Prompts: Please explain more about each strategy mentioned, the campaign
5. Do you organize awareness campaigns or trainings on AMR, infection control, antibiotic use or related issues for hospital staff?  
Prompts: If yes, please tell me more about the campaign or training. How often is it organized? Was it useful? Did you undergo post training evaluation on the trained staffs? Who delivered the trainings?
6. Are you familiar with antibiotic stewardship programme?  Yes       No  
Prompts: If yes, do you currently implement the programme in your facility? If no, do you plan to incorporate it in your future plans on AMR containment?

7. Do you undertake surveillance of new infections and AMR in the hospital?

Prompts: If yes, how often is it done? What measures did you carry out after conducting the surveillance?

8. From your professional experience, can you think of potential factors that might influence the AMR containment practice in the hospital?

Prompts: The promoting factors and limiting factors for the AMR containment?

9. What possible measures do you recommend for better AMR containment practices to be implemented in this facility?

Prompts: Please relate your recommendations with your future plans

**Thank you for your time**

## **II. Interview guide for Infectious disease specialists**

1. Do you face any challenge in your daily practice as a result of AMR?

2. How do you explain your role in AMR containment?

Prompts: In relation with infection control practices and rational prescribing in the hospital?

3. How do you describe the utilization of laboratory findings in the diagnosis of infectious etiologies?

Prompts: What are the potential reasons for the preference of empiric antimicrobial therapy, use of broadspectrum antibiotics? Do you have any complaints on the laboratory service?

4. Did you attend awareness campaigns or formal training on AMR, infection control, antibiotic use or related issues conducted?

Prompts: How recent was it conducted? Was it provided for mass health care professionals or selected ones? Do you think this influenced your practice? Do you undergo post training evaluations?

5. Do you assess patients who may require urgent isolation for conditions that require additional precautions (transmission-based precautions)?

Prompts: Who is responsible for such patient placements? Is there a designated room available for such patients? How do you handle patient placement with regard to ventilation of the designated isolation room and barrier precautions?

6. The following practices are known to contribute to antimicrobial resistance. Please explain on how commonly each of them exist in your hospital?

- A. Prescribing antimicrobials when they are not needed
- B. Limited use of laboratory services for diagnosis of infectious etiologies
- C. Poor infection control in the hospital
- D. Antibiotics are often not available
- E. Poor hand hygiene practice among clinicians

7. From your professional experience, can you think of potential factors that might influence the AMR containment practice in the hospital?

Prompts: The promoting factors and limiting factors for the AMR containment?

8. What possible measures do you recommend for better AMR containment practices to be implemented in this facility?

Prompts: Please relate your recommendations with your future plans

9. If there is anything you would like to add

**Thank you for your time**

### **III. Interview guide for head nurses**

1. Do you face any challenge in your daily practice as a result of AMR?

2. What do you currently practice to reduce the transmission and promote the control of infections in the hospital?

Prompts: Explain your participation on isolation procedures, implementation of hand hygiene, barrier precautions and other infection control practices in the hospital?

3. Did you attend awareness campaigns or formal training on AMR, infection control, antibiotic use or related issues conducted?

Prompts: How recent was it conducted? Was it provided for mass health care professionals or selected ones? Do you think this influenced your practice? Do you undergo post training evaluations?

4. Do you assess patients who may require urgent isolation for conditions that require additional precautions (transmission-based precautions)?

Prompts: Who is responsible for such patient placements? Is there a designated room available for such patients? How do you handle patient placement with regard to ventilation of the designated isolation room and barrier precautions?

5. The following practices are known to contribute to antimicrobial resistance. Please explain on how commonly each of them exist in your hospital?

A. Poor infection control in the hospital

B. Poor hand hygiene practice among clinicians

6. From your professional experience, can you think of potential factors that might influence the AMR containment practice in the hospital?

Prompts: The promoting factors and limiting factors for the AMR containment?

7. What possible measures do you recommend for better AMR containment practices to be implemented in this facility?

Prompts: Please relate your recommendations with your future plans

8. If there is anything you would like to add

**Thank you for your time**

#### **IV. Interview guide for head pharmacists**

1. Do you face any challenge in your daily practice as a result of AMR?

2. How do you explain the availability of antimicrobial medicines in this facility?

Prompts: Which quantification method do you apply? Why?

3. Did you attend awareness campaigns or formal training on AMR, infection control, antibiotic use or related issues conducted?

Prompts: How recent was it conducted? Do you think this influenced your practice? Do you undergo post training evaluations?

4. Does this hospital have an established DTC?  Yes  No

Prompts: If yes, is it functional? Please elaborate the role of DTC regarding AMR control

5. Is there a medicines formulary or drug list specific to this hospital?  Yes  No

Prompts: If yes, do you apply antibiotic restriction and rotation system on the hospital formulary? How do you ensure the distribution of the formulary for the prescribers and their adherence to it?

6. How do you control the use of antibiotics in the hospital?

7. How do you describe the antimicrobial prescribing practice in the hospital?

Prompts: In relation with broadspectrum antibiotics, combination antibiotics and poly pharmacy of antibiotics; do you promote rational antibiotic prescribing and use? How?

8. Do you employ any method(s) to improve compliance with optimal antibiotic prescribing?

Prompts: If yes, how effective do you believe this method is at improving practices?

9. The following practices are known to contribute to antimicrobial resistance. Please explain on how commonly each of them exist in your hospital?

A. Prescribing antimicrobials when they are not needed

B. Lack of proper patient counseling on prescription medicines

D. Poor infection control

E. Antibiotics are often not available

10. From your professional experience, can you think of potential factors that might influence the AMR containment practice in the hospital?

Prompts: The promoting factors and limiting factors for the AMR containment?

11. What possible ways/methods do you recommend for better AMR containment practices to be implemented in this facility?

Prompts: Please relate your recommendations with your future plans

12. If there is anything you would like to add

**Thank you for your time**

## **V. Interview guide for microbiologists/ head of microbiology laboratory**

1. Do you face any challenge in your daily practice as a result of AMR?

2. Do you perform culture and sensitivity test?  Yes  No

Prompts: If yes, on what basis or requisition is the test done? Are microbiology records routinely kept? Is there summary reporting of results on antibiotic susceptibility patterns?

3. Is the Infection Control Committee or person in charge of infection control usually notified if resistant bacterial strains are isolated?  Yes  No

4. From your professional experience, how do you explain physicians' reliance on laboratory findings for prescribing antimicrobials?

Prompts: Were there any complaints you receive from the physicians? Are there any possible factors limiting the laboratory service (culture and sensitivity tests)?

5. Did you attend awareness campaigns or formal training on AMR, infection control, antibiotic use or related issues conducted?

Prompts: How recent was it conducted? Do you think this influenced your practice? Do you undergo post training evaluations?

6. The following practices are known to contribute to antimicrobial resistance. Please explain on how commonly each of them exist in your hospital?

- A. Poor use of culture and sensitivity test results
- B. Poor infection control in the laboratory
- C. Poor infection control in the hospital
- D. Insufficient qualified human resources
- E. Work overload
- F. Inadequate equipment
- G. Inconsistent supply of required reagents
- H. Limited appreciation of the laboratory role

7. Does the hospital have a system in place for surveillance of new infections and antimicrobial resistant organisms?  Yes  No

8. From your professional experience, can you think of potential factors that might influence the AMR containment practice in the hospital?

Prompts: The promoting factors and limiting factors for the AMR containment?

9. What possible measures do you recommend for better AMR containment practices to be implemented in this facility?

Prompts: Please relate your recommendations with your future plans

10. If there is anything you would like to add

**Thank you for your time**

### Annex III: Observation checklist

<b>Facility assessment</b>	<b>A</b>	<b>NA</b>	<b>Remark</b>
<b>Patients Triage</b>			
Visual alerts such as posters are displayed at the entrance of hospital to alert patient on symptoms of communicable respiratory infections			
Designated waiting area for patients with infectious symptoms to minimize cross infection			
A designated isolation room is available for patients with respiratory symptoms			
This designated isolation room is equipped with:			
i) Hand washing facilities			
ii) Alcohol-based handrub			
Remark: The triage is over crowded/ less crowded			
<b>Hand Hygiene</b>			
Availability and easy accessibility of sinks			
Complete set of handwashing facilities			
Alcohol-based hand antiseptics			
Hand lotion			
Containers for liquid soap			
Disposable towel			
Hot air drier			
<b>Personal Protective Equipment (PPE)</b>			
PPEs (include surgical mask, N95 respirator, face shield, gown and gloves) are available and worn by clinicians during patient care			
PPEs (include surgical mask, N95 respirator, face shield, gown and gloves) is worn by staff working in patient wards			

Face mask is offered with education given to patients and visitors			
<b>Environment Control</b>			
Adequate dedicated hand washing sinks			
Waiting room and reception areas (Remark: over crowded/ Less crowded)			
Separate isolation room for symptomatic contagious patients			
Separate rest rooms for staff and patient use			
Ventilation of the hospital environment (mainly patient triages, wards, isolation, treatment and examination rooms) Remark: Adequate air circulation/ Inadequate air circulation			
Natural ventilation system Remark: Adequate air circulation/ Inadequate air circulation			
Availability of mechanical ventilation system			
<b>Waste Management</b>			
Sharps box is secured in an upright position and in a convenient place near to where the sharps are used			
Sharps boxes are sealed up and discarded into colored plastic bags (Remark: marked or not marked)			
Puncture-resistant sharps-disposal containers ( in injection rooms, treatment rooms, wards, operating theaters, labor and delivery rooms and laboratories)			
Domestic waste e.g. office paper and other items are placed in separated waste bag for disposal			
Clinical infectious waste e.g. sharps boxes, dressings/swabs and all other waste dripping with blood and other potentially infected waste is separately (from non-infectious waste) placed in			

colored plastic waste bags			
<b>Microbiology Laboratory</b>			
Safety cabinets (Bio-safety cabinets)			
Data recording system			
Data reporting system			
Barrier precaution facilities			
Ventilation Remark: Adequate air circulation/ Inadequate air circulation			
Hand washing sink, soap, towel			
Alcohol based hand rub			
Functional refrigerator			
No food or drink stored in the refrigerator			
Waste containers			
Infectious waste e.g. sharps boxes, waste dripping with blood and other potentially infected waste is separately (from non-infectious waste) placed in colored plastic waste bags			
<b>Pharmacy</b>			
Hand hygiene facilities			
Controlled or limited access area with nonporous washable floors			
Functional refrigerator			
No food or drink stored in the refrigerator			