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Original article

Antibiotic use evaluation using WHO methodology in a private hospital, Yangon, Myanmar

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ABSTRACT

Reliable data on antibiotic consumption is a prerequisite for understanding the situation of antibiotic use. In this study, we aimed to evaluate antibiotic use, antibiotic consumption patterns, and antibiotic prescribing patterns in the outpatient and inpatient departments (OPD and IPD, respectively) of a private hospital in Yangon, Myanmar. This retrospective cross-sectional study was conducted in 2017. Antibiotic use data from January-December 2017 was retrieved from the hospital database and medical records, which included 9,134 and 4,140 outpatient and inpatient, respectively, antibiotic-containing prescriptions. The World Health Organization (WHO) unit measurement (defined daily dose, DDD) and prescribing indicators were used for evaluating antibiotic consumption and prescribing patterns, respectively. Antibiotics were administered in 21% of outpatient visits and 70% of inpatient admissions. Regarding antibiotic consumption, 44,959 and 31,861 DDDs were consumed in OPD and IPD, respectively. Broad-spectrum antibiotics (beta-lactam penicillins, fluoroquinolones, and third-generation cephalosporins) were mostly prescribed in both OPDs and IPDs. Moreover, antibiotics were mostly prescribed for respiratory tract infections and acute viral infections in the OPD. Almost all prescribing indicators were acceptable in accordance with the WHO standard values, except the rate of generic prescription, which was lower than the recommended rate. The findings suggested that the government sector and hospitals should develop policies and regulations to evaluate antibiotic use. Prescription practice guidelines for antibiotics are needed to ensure appropriate medicine use. Furthermore, important findings of this study could contribute to the design of various interventions to promote rational use of antibiotics.

1. INTRODUCTION

Antibiotics are widely used worldwide, with approximately a third of all patients receiving at least one antibiotic during hospitalization[1,2]. However, a previous study showed that approximately half of the 100 million antibiotics prescribed by physicians yearly were not necessary[3]. Inappropriate or irrational use of antibiotics will definitely lead to antibiotic resistance (ABR), which is a global health problem causing therapeutic failure, increased health care costs, morbidity, and mortality[4,5]. In the past few decades, many studies have reported that the development of ABR is influenced by the patterns of antibiotic utilization and the rationality of antibiotic prescription behaviors. Therefore, most developed countries have already established surveillance programs to study patterns and trends

of antibiotic consumption[6,7]. However, surveillance systems for rational antibiotic use in low-income and middle-income countries need improvement, or antibiotic consumption reviews and interventions to combat ABR need to be expanded[8].

Thus, the World Health Organization (WHO) stated that reliable and proper data on medicine use are required to establish problem areas and implement intervention strategies. To track the number of antibiotics used in hospitals or in the community, the WHO has introduced a technical unit of measurement, defined daily dose (DDD) that measures the overall drug consumption based on the usual daily dose for a specific drug. DDD is used to provide a common measurement of quantity for different medicines so that the volumes of consumption are comparable and the trends of drug consumption between population groups are easy to assess[9]. Furthermore, the prescribing indicators have been implemented to assess the documentation of all components (medicines and indications) in a prescription[10]. However, in most developing countries, government monitoring of antibiotic prescription by regulatory bodies has not been initiated. The situational analysis of medicines in healthcare delivery in 2014 in Myanmar revealed that there was a need to monitor and review drug use in the healthcare system, and there was a lack of a national drug formulary manual and poor use of standard treatment guidelines (STGs). In terms of antibiotic utilization, unregulated sales of antibiotics, lack of awareness of ABR among the public, and inadequate data on antibiotic consumption are the challenges faced in Myanmar. Moreover, in government hospitals, monitoring of drug utilization data in a computerized system has not been implemented, leading to insufficient data recording for now and in the future. In contrast, in most private hospitals, a computerized system is used to monitor drug use that contributes to data resources other than public hospitals[11,12].

Baseline data on antibiotic consumption and prescribing patterns are a prerequisite for understanding and providing a descriptive overview of antibiotic use at healthcare facilities and monitoring the ongoing monthly or yearly antibiotic use in the future. Hence, the main aim of this study was to assess antibiotic use, antibiotic consumption patterns, and antibiotic prescribing patterns in the outpatient and inpatient departments (OPD and IPD, respectively) of a private hospital in Yangon, Myanmar.

2. MATERIALS AND METHODS

This retrospective, cross-sectional study conducted in a private hospital in Yangon, Myanmar, focused on the situation of antibiotic use, whereby antibiotic consumption and prescribing patterns were assessed using the WHO unit measurement DDD, and WHO prescribing indicators, respectively, using data from January to December 2017.

2.1. Sample size determination

To analyze antibiotic consumption patterns using DDD, all outpatient and inpatient prescriptions containing antibiotics given in the period of January-December 2017 were included in the study. To assess prescribing patterns, the proper sample size was required for each OPD and IPD; medical records of patients with chronic illnesses were excluded. According to the WHO guidelines on investigating drug use patterns, 600 outpatient medical records and 100 inpatient medical records should be included in any study conducted to evaluate prescribing patterns in health facilities[13,14] as described in Figure 1. A sampling interval was required to select 600 outpatient and 100 inpatient medical records. Thus, the sampling interval for each outpatient and inpatient medical record was calculated as the total number of medical records containing antibiotics prescriptions given in 2017 divided by the required sample size.

2.2. Data instruments

To measure the antibiotic consumption level, the WHO Guidelines for Anatomical Therapeutic Chemical (ATC) classification and DDD assignment were used to categorize the antibiotics prescribed and calculate the total consumption rate as DDDs. The DDD methodology alters and standardizes available drug quantity data (e.g., packages, tablets, and bottles) into crude estimates of clinical exposure to drugs[5,15]. The total numbers of antibiotics dispensed were multiplied by the dose strength and divided by the WHO DDD for each antibiotic type as follows.

$$\text{Total consumption (DDDs)} = \frac{\text{Number of doses used}^{*} \times \text{dose strength (g)}}{\text{WHO DDD (g)}}$$

*Number of doses used e.g. numbers of tablets, vials, and bottles

To evaluate the antibiotic prescribing patterns in the study hospital, the WHO's set of validated drug use indicators was used. The prescribing indicators measure the patterns of

prescription and assess the appropriateness of medicine use in general. These prescriptions could be observed retrospectively from historical medical records, in which there are five indicators for the OPD and four indicators for the IPD. The indicators should be applied in the healthcare facilities over time as a monitoring process for regulating prescribing patterns in a proper manner[13,14].

The indicators for the OPD are as follows:

1. Average number of antibiotics per prescription, calculated as the total number of different antibiotics in prescriptions divided by the number of prescriptions with antibiotics. This indicator is used to measure the number of multiple antibiotics prescribed per patient (polypharmacy).
2. Percentage of antibiotics prescribed by generic names, calculated as the number of antibiotics prescribed by generic names divided by the total number of different antibiotics in prescriptions and multiplied by 100. This indicator measures the number of antibiotics being prescribed by generic names.
3. Percentage of prescriptions with antibiotics, calculated as the number of prescriptions with antibiotics divided by the total number of prescriptions in the study and multiplied by 100, which indicates the overall antibiotics use.
4. Percentage of prescriptions with antibiotic injections, calculated as the number of prescriptions with antibiotic injections divided by the number of prescriptions with antibiotics and multiplied by 100. This measure shows the percentage of antibiotic injections being prescribed in OPD and indicates unnecessary use of injections.
5. Percentage of prescription of antibiotics from the WHO essential medicines list (EML), calculated as the number of antibiotics prescribed from the WHO EML divided by the total number of different antibiotics in the prescriptions and multiplied by 100, which indicates the percentage of essential antibiotics prescribed from WHO EML.

The purpose of the indicators for the IPD are the same as those for the OPD. The indicators for the IPD are as follows:

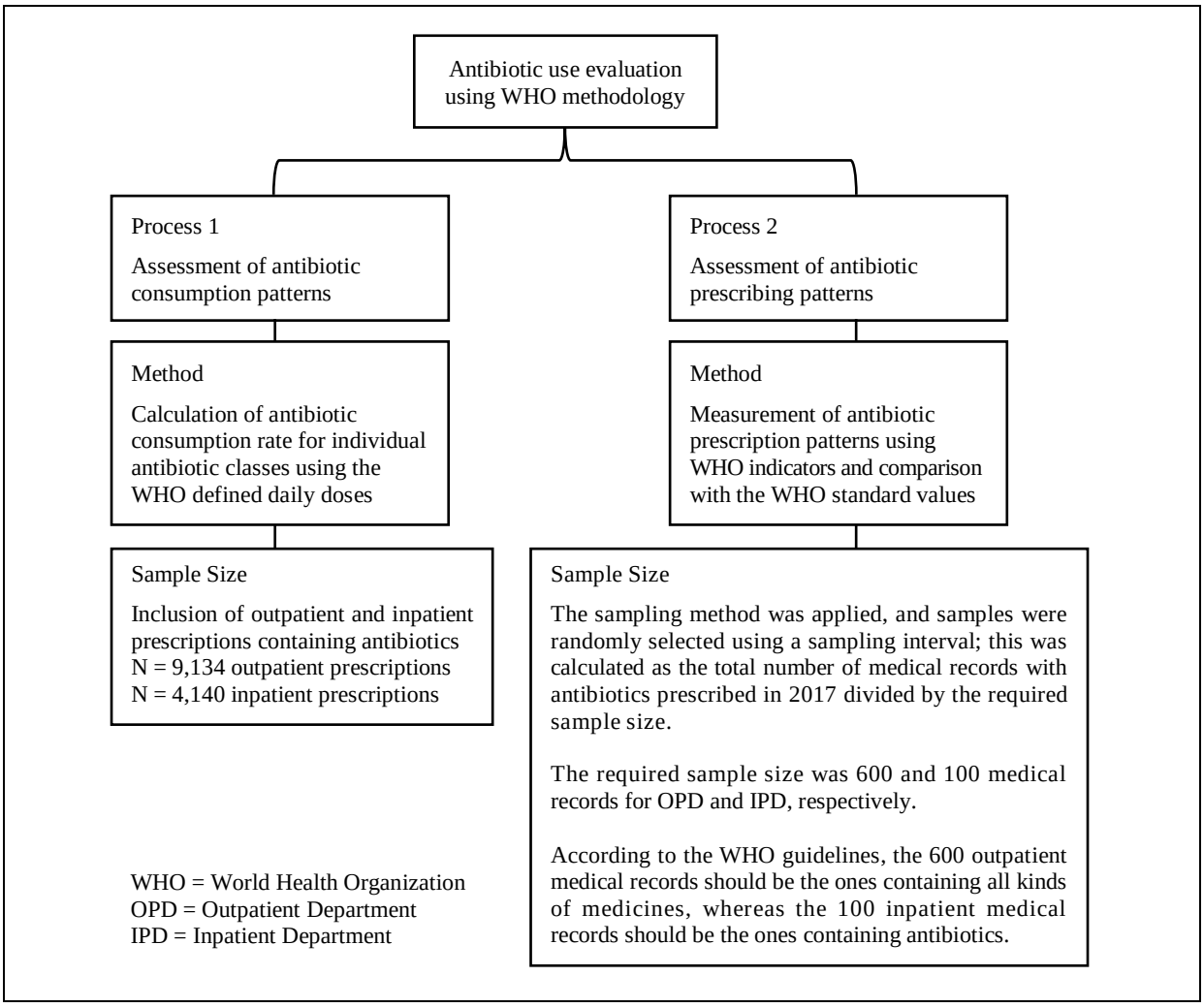

Figure 1. Flow chart of the methods applied in the study

1. Average number of antibiotics prescribed per hospitalization, calculated as the total number of antibiotics of the same generic type prescribed divided by the number of hospitalizations for the study period.
2. Percentage of antibiotics prescribed by generic name, calculated as the total number of antibiotics prescribed by generic name divided by the total number of different antibiotics prescribed and multiplied by 100.
3. Percentage of hospitalizations with antibiotics prescribed, calculated as the number of hospitaliza -tions with antibiotics prescribed divided by the total number of hospitalizations and multiplied by 100.
4. Percentage of antibiotics prescribed from the WHO EML, calculated as the number of antibiotics prescribed from the WHO EML divided by the total number of different antibiotics prescribed and multiplied by 100.

2.3. Data collection and analysis

For DDD measurement for antibiotics, all pharmacy records for 2017 were collected and then filtered into the database containing only raw antibiotic data, as provided by the hospital from the computerized system. Individual types of generic antibiotics were grouped for ease of calculating DDDs of each antibiotic type. Data on prescribing patterns were collected manually because there were no computerized prescription records of diagnosis. The form used for data collection was specifically developed for the study and included age, sex as well as details of any antibiotics that had been prescribed (generic or brand name, dose, and frequency). All data collected were entered into Microsoft Excel and analyzed.

3. RESULTS

The results included consumption data for individual antibiotic classes, in terms of overall patients with antibiotics prescriptions and DDD measurement for each antibiotic class. Moreover, antibiotic prescribing patterns were determined by applying the WHO prescribing indicators and the results were compared to the WHO standard values. The classification of diagnoses associated with antibiotic prescription is also mentioned in this section.

3.1. Antibiotic consumption

A total of 9,134 outpatient and 4,140 inpatient prescriptions containing antibiotics were given during that time period. Table 1 shows the 1-year consumption of various classes of antibiotics measured as total DDDs at the OPD. In 2017, 44,717 DDDs of antibiotics were consumed via the oral route, and the three most dispensed antibiotics were broad-spectrum beta-lactam antibiotics, fluoroquinolones, and macrolides. Only 242 DDDs for all antibiotic classes administered via the parenteral route were prescribed in the OPD.

In addition, a total of 21,568 DDDs of antibiotics were consumed via the oral route at the IPD, and the three most consumed antibiotics were second-generation cephalosporins, broad-spectrum beta-lactam antibiotics, and third-generation cephalosporins, as shown in Table 2. The total DDDs of antibiotic injections for hospitalized patients were 10,293 DDDs, and the most prescribed parenteral antibiotics were third-generation cephalosporins, fluoroquinolones, and second-generation cephalosporins.

Table 1. Oral and parenteral antibiotic consumption patterns in defined daily doses at the outpatient department

No	Antibiotic Classes (Oral)	Total Consumption (DDDs)	Antibiotic Classes (Parenteral)	Total Consumption (DDDs)
1	Beta-lactam antibiotics (BS)	14,780	Aminoglycosides	116
2	Fluoroquinolones	9,998	Third-generation cephalosporins	69
3	Macrolides	6,203	Fluoroquinolones	13
4	Third-generation cephalosporins	5,437	Beta-lactam antibiotics (BS)	11
5	Tetracyclines	2,550	Second-generation cephalosporins	8
6	Second-generation cephalosporins	2,333	Beta-lactamase–resistant antibiotics	7
7	Beta-lactam antibiotics (NS)	1,829	Beta-lactam antibiotics (NS)	6
8	Others	1,587	Others	12
	Total	44,717	**Total**	242

BS: broad-spectrum; NS: narrow-spectrum; DDD: define daily dose

Table 2. Oral and parenteral antibiotic consumption patterns in defined daily doses at the inpatient department

No	Antibiotic Classes (Oral)	Total Consumption (DDDs)	Antibiotic Classes (Parenteral)	Total Consumption (DDDs)
1	Second-generation cephalosporins	5,909	Third-generation cephalosporins	5,373
2	Beta-lactam antibiotics (BS)	4,619	Fluoroquinolones	1,687
3	Third-generation cephalosporins	4,591	Second-generation cephalosporins	1,049
4	Fluoroquinolones	2,862	Beta-lactam antibiotics (BS)	1,047
5	Macrolides	1,848	Aminoglycosides	510
6	Rifamycin derivatives	708	Beta-lactamase–resistant antibiotics	239
7	Tetracyclines	401	Carbapenem	230
8	Others	630	Others	158
	Total	21,568	**Total**	10,293

BS: broad spectrum; NS: narrow spectrum; DDD: define daily dose

3.2. Antibiotic prescribing patterns

Six hundred prescriptions from the OPD were collected to review if antibiotics were prescribed, of which 170 prescriptions contained 188 different antibiotics. The first prescribing indicator among the WHO prescribing indicators measured the average number of antibiotics per prescription, the result for which was 1.1. Second, the number of antibiotics prescribed by generic name was 65 among a total of 188 antibiotics; thus, the percentage of antibiotics prescribed by generic name was 34.6%, as shown in Table 3. Third, the percentage of antibiotic prescription accounted for 21% (9,134 of prescriptions with antibiotics out of a total of 43,469 prescriptions). With regard to the result for the fourth indicator, antibiotic injections merely administered at the OPD accounted for 2.4%. The fifth prescribing indicator revealed the percentage of antibiotics prescribed from the WHO EML (84%).

At the IPD, a total of 5,904 of patients were hospitalized in 2017, of which the number of hospitalizations with antibiotics prescribed was 4,140 (70%). Moreover, 100 medical records with antibiotic prescription during hospitalizations were randomly selected and reviewed, for which the average number of antibiotics prescribed per hospitalization was 1.4. The percentage of antibiotics prescribed by generic name was 32.5%, and the percentage of antibiotics prescribed from the WHO EML was 82.5% (Table 3).

Table 3. World Health Organization prescribing indicators at the outpatient and inpatient departments

No	WHO prescribing indicators	WHO Standard Values	Results	
			OPD (N = 170)	IPD (N = 100)
1	Average number of antibiotics per prescription/hospitalization	Less than 2 (Between 1 and 2 tablets/capsules)	1.1	1.4
2	Percentage of antibiotics prescribed by generic name	100%	34.6%	32.5%
3	Percentage of prescriptions with antibiotics	20-30%	21.0%	70.0%
4	Percentage of prescriptions with an antibiotic injection	10-25%	2.4%	-
5	Percentage of antibiotics prescribed from the WHO EML	100%	84.0%	82.5%

WHO EML: World Health Organization essential medicines list; OPD: outpatient department; IPD: inpatient department

Table 4. Distribution of diagnoses with antibiotic prescription at the outpatient department

No	Diagnosis	Frequency (N = 170)	%
1	Upper respiratory tract infections	44	26%
2	Minor injuries or infections	36	21%
3	Lower respiratory tract infections	14	8%
4	Acute viral infections	13	8%
5	Diagnosis not mentioned	13	8%
6	Others	50	29%
	Total	170	100%

Table 5. Distribution of diagnoses with antibiotic prescription at the inpatient department

No	Diagnosis	Frequency (N = 100)	%
1	Elective lower segment cesarean section	31	31%
2	Non-surgical	28	28%
3	Surgical	17	17%
4	Respiratory infections	7	7%
5	Carcinoma	6	6%
6	Others	11	11%
	Total	100	100%

Assessment of the prescriptions according to the diagnosis types at the OPD showed that the antibiotics were most commonly prescribed for upper respiratory tract infections (URTIs, 26%) as shown in Table 4. Furthermore, antibiotics were frequently included in the prescriptions for minor injuries (21%), lower respiratory tract infections (8%), and acute viral infections (8%). According to the diagnosis types at the IPD, antibiotics were mostly prescribed for elective lower segment cesarean section (31%). Individual hospitalization cases by diagnosis type with the antibiotics prescribed are summarized in Tables 4 and 5.

4. DISCUSSION

This is one of the first studies from a developing country, Myanmar that describes antibiotic consumption and prescription in the patient population for the year 2017 (January-December) to obtain baseline data of antibiotic use in a private hospital. In the study, DDD measurement was used to assess antibiotic consumption, in which physical quantities (tablets, capsules, ampoules, etc.) were transformed into standard units of individual antibiotic classes. The most commonly prescribed antibiotics in the OPD and IPD were beta-lactam antibiotics, second- and third-generation cephalosporins, fluoroquinolones, macrolides, and tetracyclines while third-generation cephalosporins, fluoroquinolones, aminoglycosides, and beta-lactam antibiotics were largely used in OPDs and IPDs in India[16]. Parenteral antibiotics were administered more often in the IPD than in OPD, as prophylactic antibiotics were available for surgical cases. In Europe, 29 countries reported the annual antibiotic consumption data to show the differences between years, which could help evaluate antibiotic stewardship interventions in these countries[17]. However, antibiotic consumption data cannot by itself indicate the quality of antibiotic use since corresponding data (e.g., resistance patterns, national guidelines, and disease prevalence) are required for optimal antibiotic use.

With regard to the antibiotic prescribing patterns, the average number of antibiotics per prescription did not exceed the WHO standard value (less than 2). Physicians' awareness of the negative outcomes of polypharmacy, such as an increased risk of drug interactions and the emergence of resistance, might decrease the number of drugs per prescription. Moreover, prescription of generic antibiotics may reduce the cost of treatment[13,14]. In this study, the percentage of generic antibiotics prescription was very low, and the underlying reasons may be profit-driven attitude, highly powered salesmanship of pharmaceutical companies, and formulary lists describing only brand names.

The rate of antibiotic use may depend on factors, such as cultural beliefs, physician's knowledge, and disease prevalence. The percentage of antibiotic use in the OPD was acceptable, i.e., within the WHO standard range (20.0-26.8%). However, the rate of hospitalizations with antibiotics prescribed in the IPD was higher than the WHO standard value, attributable to a large number of patients who required antibiotic prophylaxis or a high prevalence of infection-related cases. Every needle for parenteral administration should be sterilized to prevent blood-borne infections, and the percentage of antibiotic injection is supposed to be lower than in the OPD. However, the study revealed a lower value than the WHO standard value (13.4-24.1%).

Eventually, most of the countries have to comply with the prescribing of drugs according to the WHO EML. This is beneficial in terms of cost-effectiveness and safety, as drugs are selected with regard to local disease prevalence as well as evidence of efficacy and safety[18]. The percentages of antibiotics prescribed from the WHO EML were 84% for the OPD and 82.5% for the IPD and were lower than the WHO standard value (100%). However, the percentages obtained in this study were higher than that in public hospitals (75%). Antibiotic prescription should comply with the WHO or national EML since selection of drugs from these lists promotes rational drug prescription.

As most URTIs are viral, antibiotic prescription may be unnecessary[19]. In this study, antibiotic use for URTIs was found and the underlying reason may be a lack of culture testing in the OPD, which might cause prognostic uncertainty and diagnostic complexity for antibiotic prescription decisions for URTIs. Moreover, antibiotics were prescribed for acute viral infections, showing antibiotic misuse. In such cases, physicians should have described in more detail the reasons for antibiotic prescription for these viral infections. Subsequently, antibiotic prescriptions with no defined diagnoses might lead to inappropriate prescribing. The quality of antibiotic use should be determined according to national or international guidelines such as evidence-based antibiotic prescription guidelines.

There are some limitations of our study. The study was conducted for a 1-year period because the study hospital started using a computerized database in 2017 and pre-2017 drug consumption data were unavailable in the system. Therefore, comparisons between years were not possible. Besides, the appropriateness of antibiotic treatments could not be assessed due to the limited allowance of the study hospital, the lack of detailed and adequate information for antibiotic prescription by physicians for each diagnosis. Despite these limitations, this study provides baseline data on antibiotic use patterns and is also the first study on antibiotic use in Myanmar conducted with the WHO-recommended methods. The DDD measurement could be applied in other public or private hospitals since the result would provide a statistical measure of drug consumption independent of price, currency, package size, and dose. WHO prescribing indicators could also help examine the knowledge or proficiency of the prescribers, from which researchers could further determine solutions or ways to improve prescribing behaviors for specific diagnoses or group of drugs.

5. CONCLUSION

This study revealed a set of circumstances in which antibiotics were incorrectly used: a high level of newer and broad-spectrum antibiotic consumption, frequent use of brand names in prescription, unnecessary antibiotic use for URTIs and acute viral infections, and lack of diagnoses in prescriptions. Furthermore, it highlighted the importance of determining improper antibiotic use in hospitals by applying the standardized methodology recommended by the WHO. Such inappropriate antibiotic prescription practice would serve as great evidence for further interventions or measurements to address the issue of irrational antibiotic use.

At the hospital level, regular surveillance for resistance patterns and antibiotic utilization patterns is required, because it would help provide correct empirical antibiotic therapy. Based on the irrational antibiotic prescription practices found in this study, a centralized meeting or training should be conducted regularly, to share the latest knowledge, experiences, ideas, and problems that would help physicians improve their prescription decisions. At a national level, it is necessary to have a well-organized system for monitoring the use of medicines including antibiotics followed by the corresponding resistance patterns and disease prevalence. Furthermore, since URTI cases are mostly viral and antibiotics are not necessary, the government should formulate national treatment guidelines, especially for URTIs, to promote rational prescription of medicines.

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Conflict of interest
None to declared.

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Ethics approval
The research protocol was submitted to the Institutional Review Board of Defense Services Medical Research Centre in Nay Pyi Taw, Myanmar on 23rd January 2018. The ethical approval number is IRB/2018/2, signed on 30th January 2018. Moreover, the respective persons of the study hospital have approved the use of data included in the present study.

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REFERENCES

1. Lim VK, Cheong YM, Suleiman AB. Pattern of antibiotic usage in hospitals in Malaysia. Singapore Med J. 1993;34(6):525-8.
2. Thu TA, Rahman M, Coffin S, Harun-Or-Rashid M, Sakamoto J, Hung NV. Antibiotic use in Vietnamese hospitals: a multicenter point-prevalence study. Am J Infect Control. 2012;40(9):840-4.

3. Holloway KA, Kotwani A, Batmanabane G, Puri M, Tisocki K. Antibiotic use in South East Asia and policies to promote appropriate use: reports from country situational analyses. BMJ. 2017;358:9-13.
4. Kebede HK, Gesesew HA, Woldehaimanot TE, Goro KK. Antimicrobial use in paediatric patients in a teaching hospital in Ethiopia. PLoS One. 2017;12(3): e0173290.
5. Al-Jumaili AA, Hussein AH, Al-Rekabi MD, Raheem SA, Ernst EJ. Antimicrobial utilization in an Iraqi province: a comprehensive evaluation of antibiotic source and cost. Int J Pharm Pract. 2017;25:81-8.
6. Vander Stichele RH, Elseviers MM, Ferech M, Blot S, Goossens H; ESAC Project Group. European surveillance of antimicrobial consumption (ESAC): data collection performance and methodological approach. Br J Clin Pharmacol. 2004;58:419-28.
7. Pelle B, Gilchrist M, Lawson W, Jacklin A, Franklin BD. Using defined daily doses to study the use of antibacterials in UK hospitals. Hospital Pharmacist. 2006;13:133-6.
8. Kotwani A, Holloway K. Trends in antibiotic use among outpatients in New Delhi, India. BMC Infect Dis. 2011;11:99.
9. WHO Collaborating Centre for Drug Statistics Methodology. Guidelines for ATC Classification and DDD Assignment, Oslo 2016; 2016[cited 2020 June 24]. Available from: http://www.whocc.no/filearchive/publications/2019_guidelines_web.pdf.
10. Alharafsheh A, Alsheikh M, Ali S, Baraiki AA, Alharbi G, Alhabshi T, Aboutaleb A. A retrospective cross-sectional study of antibiotics prescribing patterns in admitted patients at a tertiary care setting in the KSA. Int J Health Sci (Qassim). 2018;12(4):67-71.
11. Kumar J, Shaik M, Kathi M, Deka A, Gambhir SS. Prescribing indicators and pattern of use of antibiotics among medical outpatients in a teaching hospital of Central Nepal. J Coll Med Sci Nepal. 2010;6:7-13.
12. World Health Organization. Medicines in Health Care Delivery Myanmar: Situational Analysis 2014; 2014 [cited 2020 June 24]. Available from: http://www.who.int/docs/defaultsource/searo/hsd/edm/csa-myanmar-2014.pdf. Accessed on 24.6.20.
13. World Health Organization. How to Investigate Drug Use in Health Facilities 1993; 1993 [cited 2020 June 24]. Available from: http://www.who.int/medicinedocs/index.fcgi?a=d&d=Js22893.
14. Strengthening Pharmaceutical Systems. How to Investigate Antimicrobial Use in Hospital: Selected Indicators; [cited 2020 June 24]. Available from: http://www.who.int/ medicinedocs/documents/s21031en/s21031en.pdf.
15. Sozen H, Gonen I, Sozen A, Kutlucan A, Kalemci S, Sahan M. Application of ATC/DDD methodology to evaluate antibiotic use in a general hospital in Turkey. Ann Clin Microbiol Antimicrob. 2013;12(1):23.
16. Sharma M, Eriksson B, Marrone G, Dhaneria S, Lundborg CS. Antibiotic prescribing in two private sector hospitals; one teaching and one non-teaching: a cross-sectional study in Ujjain, India. BMC Infect Dis. 2012;12(1):155.
17. European Centre for Disease Prevention and Control. Antimicrobial Consumption in ECDC: Annual Epidemiological Report for 2016; 2016 [cited 2020 June 24]. Available from: http://www.ecdc.europa.eu/sites/default/files/documents/AER-for-2016-AMC.pdf.
18. World Health Organization. WHO Model List of Essential Medicines 2017; 2017 [cited 2020 June 24]. Available from: http://www.who.int/medicines/publications/essentialmedicines/en.pdf.
19. Yoon YK, Park CS, Kim JW, Hwang K, Lee SY, Kim TH, et al. Guidelines for the antibiotic use in adults with acute upper respiratory tract infections. Infect Chemother. 2017;49 (4):326-52.