THE CURRENT SITUATION OF ANTIBIOTIC USE IN THE ORTHOPEDIC TRAUMA DEPARTMENT OF THE CENTRAL HIGHLANDS REGIONAL GENERAL HOSPITAL IN 2024

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ABSTRACT

The irrational use of antibiotics leads to an increase of antibiotic resistance, as well as rising costs of hospitalization and reduced treatment effectiveness. Our study aims to assess the usage of antibiotics in the Department of Trauma and Orthopedics at The Central Highlands Regional General Hospital. A prospective cross-sessional study was conducted over six months on antibiotic utilization in adult inpatients from February 2024 to July 2024. The data were evaluated using Anatomical Therapeutic Chemical/Defined Daily Dose (ATC/DDD) methodology, the Drug Utilization 90% (DU90%) Index, and the World Health Organization's Access, Watch and Reserve (WHO AWaRe) classification. The study findings revealed that antibiotics were primarily administered through injection, comprising 99.44% of total usage. Furthermore, antibiotics were exclusively utilized in the generic category, with domestically produced drugs representing a significant portion of the total usage value (72.11%). Beta-lactams accounted for the highest proportion of antibiotic consumption (57.50% of total expenditure). The highest proportions of the DDD/100 bed-days belonged to netilmicin (29.19%), ceftriaxone (27.29%), and cloxacillin (24.27%). The beta-lactams and aminoglycosides had the highest DDD/100 bed-days proportions at 36.97% and 23.00%, respectively. Among the beta-lactams, third-generation cephalosporins accounted for highest DDD/100 bed-days proportion (17.20%). Within the DU90% segment, antibiotics belonged to the Access list were gentamicin and cloxacillin, accounting for 31.58%, while antibiotics belonged to the Watch list included netilmicin, ceftriaxone and ciprofloxacin, accounting for 61.06%.

Keywords: *Antibiotics*, *Orthopedics, ATC/DDD, DU90%, WHO AwaRe.*

1. INTRODUCTION

Antibiotics have saved thousands of lives since they were discovered. With their support, modern medical care such as surgery and organ transplants have impressive progress (Laxminarayan et al, 2016). However, the irrational use of antibiotics has led to antibiotic resistance, reducing treatment efficacy, increasing the pressure to discover new antibiotics, and raising treatment costs (Luepke et al., 2017). Patients undergoing surgery have a surgical site infection rate ranging from 0.5 to 3.0%, which extended length of hospital stay by 7 to 11 days. Meanwhile, most surgical site infections could be prevented if appropriate treatment protocols were applied (Seidelman et al., 2023).

Vietnam is located in a tropical region, which is highly conductive to bacterial transmission. Additionally, Vietnam is a lower middle-income country with a high rate of antibiotic resistance. In a study conducted from 2000 to 2015 across 76 countries, Vietnam was among the nations with the highest antibiotic consumption, ranking 11th out of 76 countries with approximate 30,0 DDD per 1,000 population per day in 2015 (Klein et al., 2018). Another study investigated 390 published winning bids from 2018 to 2022 in Vietnam found that the cost of antibiotic consumption accounted for 24.7% of total medicine expenditures (equivalent to US$ 3.16 billions) and a result of 2.54 million DDDs was calculated (Vu Quoc Dat, 2024).

Assessing antibiotic usage is one of the key methods to minimize the rise of antibiotic resistance and reduce inappropriate antibiotic prescriptions (World Health Organization, 2022). ATC/DDD methodology, recommended by the World Health Organization (WHO), was widely used for monitoring and researching medicine utilization. This method provides an approach to evaluate drug usage in population and facilitates comparisons across different periods and populations (WHO Collaborating Centre for Drug Statistics Methodology, 2024). In Circular 21/2023/TT-BYT issued by the Ministry of Health in Vietnam, the application of DDD method was recommended to identify problems related to drug utilization. Additionally, the DU90% index, based on DDDs, is used to optimize antibiotic consumption (Bergman et al., 1998). The WHO AWaRe classification is another effective tool for

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managing antibiotic use and limiting bacterial resistance (World Health Organization, 2023). However, there is currently limited research utilizing these tools to assess antibiotic utilization in Vietnam. Based on our knowledge, there have not had studies applied these tools to evaluate antibiotic usage in Dak Lak. Thus, this study was planned to determine the pattern of antibiotic utilization in the Department of Trauma and Orthopedics at The Central Highlands Regional General Hospital using ATC/DDD methodology, DU90% index and the WHO AWaRe classification.

2. MATERIALS AND METHODS

2.1. Materials

Patients aged 18 years and older, had undergone surgery, had length of hospital stay of at least three days and prescribed antibiotics were selected. Patients who were transferred to another heath care unit, those who died, those unable to communicate (including individuals who did not speak Vietnamese, or were mute or deaf), and those who did not consent to participate in the study were excluded. Patient's profiles were studied and analysis using a data collection form.

2.2. Methods

The study was conducted between February 2024 and July 2024. Date collected included the patients' age, gender, and ethnic group, along with their diagnosis. Information on antibiotic prescriptions was also gathered, including the brand name, generic name, dosage, frequency, duration of treatment, and associated antibiotic costs.

DDDs and DDD/100 bed days were calculated using the following formula (Suraj et al., 2021):

Total of DDDs for each drug = (Usual dose × Quantity dispensed)/ ATC/DDD

DDD/100 bed days = Number of units administered in a given period × 100/DDD/ (number of days in the period × number of beds × occupancy index)

Department of Trauma and Orthopedics has 119 beds, with an occupancy index of 1 during the study period.

The DU90% index was applied to assess the quality of antibiotic utilization by categorizing antibiotics according to their DDD prescription quantities. This tool identified the antibiotics that constituted 90% of the total usage, based on the premise that a more concentrated use of fewer antibiotic agents indicates improved prescribing practices. The percentage of antibiotic usage was compiled and arranged in descending order from the highest to the lowest then the DU90% index was identified (WHO Collaborating Centre for Drug Statistics Methodology, 2024).

The classification of antibiotics according to WHO AWaRe was retrieved from the website:

https://www.who.int/publications/i/item/WHO-MHP-HPS-EML-2023.04

Data entry and analysis were processed using Microsoft Excel 2013 and were presented as percentages tables.

3. RESULTS AND DISCUSSION

3.1. Demographic characteristics

Table 1. Patients' demographic characteristics (n = 360)

Variable		n (%)
Age (years)	18 – 59	298 (82.78)
	≥ 60	62 (17.22)
Gender	Male	233 (64.72)
	Female	127 (35.28)
Ethnic group	Kinh	267 (74.17)
	Others	93 (25.83)

A total of 360 patients' profiles were collected in this study. Of these, 82.78% were under the age of 60, a result was higher than that observed in previous study on antibiotic usage at Tam Anh General Hospital (Nguyen Ngoc Khoi et al., 2023). The majority of participants were male, comprising 64.7% of the sample. This finding aligns with the research conducted at the Institute of Trauma and Orthopedics, Military Hospital 175, but differs from the results reported in Tam Anh General Hospital (Dang Hoang Minh et al., 2021; Nguyen Ngoc Khoi et al., 2023). The majority of patients were Kinh ethnicity, representing 74.2%. The differences between our study and other studies are likely attributable to regional differences in disease patterns, which are shaped by diverse demographic factors, geographical characteristics, and climatic conditions. Moreover, variation in sample characteristics can be attributed to differing selection criteria across studies. In the present study, we included patients aged 18 and above who underwent surgical procedures. In contrast, the study conducted by Dang Hoang Minh et al. (2021) included all individuals undergoing clean surgeries without age restrictions, while the study by Nguyen Ngoc Khoi et al. (2023) focused specifically on patients aged 18 and above who underwent clean surgical procedures.

3.2. Antibiotic consumption

Based on the findings in Table 2, antibiotic administration predominantly occurred via injection, representing 96.26% of usage, while spending on injectable antibiotics constituted 99.44% of the total expenditure on antibiotics. This high proportion of injectable antibiotic use aligns with findings from other studies. Nguyen Thi Song Ha (2022) reported an antibiotic consumption rate of 98.3% at Kien An Hospital, and Dang Thi Thuy et al. indicated a rate of 99.4% at Military Central Hospital 108. Injectable administration is recommended for cases of life-threatening infections or deep-seated infections. Bone and joint infections frequently require extended courses of injectable antibiotics. Nevertheless, in appropriate clinical contexts, de-escalation to oral antibiotics is essential to reduce treatment costs and facilitate patient management at home or at lower-level healthcare facilities (McCarthy et al., 2020). Therefore, guidelines for antibiotic de-escalation should be developed in the trauma and orthopedic department to promote more rational and cost-effective drug use. In our study, the use of antibiotics consisted entirely of generic formulations (100%). Of the prescribed antibiotics, 66.19% were domestically produced, accounting for 72.11% of the total antibiotic expenditures. These figures for both generic and domestically produced antibiotics surpass those reported in previous studies by Nguyen Thi Song ha (2022) and Dang Thi Thuy et al. (2023). Specifically, their studies observed generic antibiotic consumption rates of 93.7% and 84.9%, respectively, while domestically produced antibiotics accounted for 53.6% and 32.0%, respectively. The relatively low utilization rates of generic and domestically produced antibiotics provide evidence that a strategic approach has been adopted to prioritize these drug categories. This strategy aims to reduce overall expenditures, ensure a stable supply, and meet therapeutic needs in accordance with the directives outlined in Circular 21/2013/TT-BYT issued by the Ministry of Health of Vietnam

Table 2. Antibiotic utilization by administration route, generic or branded group, and production location.

No.	Variable		Prescriptions		Expenditure	
			n	%	Cost (1000 VND)	(%)
1	Administration route	Oral	746	96.26	284921,70	99,44
		Injectable	29	3.74	1617,28	0,56
2	Generic or branded group	Generic	775	100,00	285338,98	100,00
		Brand	0	0,00	0	0,00
3	Production location	Domestic	402	51,87	206632,43	72,11
		Import	373	48,13	79906,55	27,89

Table 3. Proportion of antibiotics in prescriptions and expenditures

No	Class of antibiotics	Prescriptions		Expenditure	
		n	%	Cost (1000 VND)	%
1	Beta-lactams	417	53.81	164765,83	57.50
1.1	Second-generation cephalosporins	97	12.52	44791,28	15.63
1.2	Third-generation cephalosporins	179	23.10	29506,55	10.30
1.3	Penicillins	141	18.19	90468,00	31.57
2	Aminoglycosides	293	37.81	112045,50	39.10
3	Quinolones	61	7.87	9298,77	3.25
4	Others	4	0.52	428,88	0.15
	Total	775	100	286538,98	100

Table 3 presents the frequency and expenditures of antimicrobial prescriptions. During the study period, beta-lactam (53,81%) was the most commonly prescribed class of antibiotics, followed by aminoglycoside (37,81%). Among beta-lactam class, third-generation cephalosporin (23,10%) was the most frequent antibiotic prescribed. This finding was in accordance with the results of the study conducted in the Department of Trauma-Orthopedics and Burns at Thai Binh General Hospital where beta-lactams was the most prescribed antibiotic, with third-generation

cephalosporins contributed to 80% of prescription. However, the study did not report any use of aminoglycoside in that Department (Phung Thanh Hung et al., 2021).

The majority of antibiotic expenditures were attributed to beta-lactams and aminoglycosides, together representing 96.6% of the total cost. Within the beta-lactam class, penicillins accounted for the most expenditure at 31.57%, followed by second-generation cephalosporins (15.63%), and third-generation cephalosporins (10.30%). Notably, although third-generation cephalosporins were the most frequently prescribed, their purchase for this group of antibiotics was the lowest among beta-lactam class. The high expenditure on penicillins may be attributed to the fact that certain penicillins, such as cloxacillin, were considerably more costly than cephalosporins like ceftriaxone. Consequently, despite the higher usage frequency of ceftriaxone, its overall procurement costs remained lower than those of cloxacillin. Thus, optimizing the use of cloxacillin to reduce treatment expenses could be considered, along with encouraging the use of lower-cost antibiotics when clinically appropriate. Compared to the study conducted at Nghe An Hospital for Traumatology and Orthopaedics, beta-lactams was the most commonly purchased antibiotics, representing 77.9% of the total. Compared to our study, the result from the study at Nghe An Hospital for Traumatology and Orthopaedics indicated that among beta-lactams, cephalosporins accounted for the largest portion of the cost at 54.1%, though third-generation cephalosporins contributed only 4.8%. Additionally, carbapenems (17.5%) were used for inpatient treatment in that study, whereas in our study, no patients were treated with carbapenems (Hoang Thi Khanh, 2018). A study conducted at a hospital in Palestin indicated that beta-lactams were the most frequently utilized antibiotic class, with first-generation cephalosporins comprising 54.3% of usage, followed by third-generation cephalosporins at 12.4%. Aminoglycosides were also commonly used, accounting for 24.5%, whereas penicillins were rarely administered, constituting only 0.01% of the total (Masalma et al., 2024). Although prescription patterns of antibiotics varied among hospitals, beta-lactams remained prominent in treatment and expenditure.

Table 4. Antibiotic consumption by agent.

No.	Antibiotic agent	ATC code	DDD usage	DDD/100 bed days	Percentage (%)
1	Netilmicin	J01GB07	1120.57	5.23	29.19
2	Ceftriaxone	J01DD04	1047.00	4.89	27.29
3	Cloxacillin	J01CF02	931.00	4.35	24.27
4	Gentamicin	J01GB03	280.00	1.31	7.31
5	Ciprofloxacin	J01MA02	175.25	0.82	4.58
6	Cefuroxime	J01DC02	128.00	0.60	3.35
7	Cefamandole	J01MA02	111.67	0.52	2.90
8	Oxacillin	J01DC02	34.00	0,16	0.89
9	Vancomycin	J01XA01	6.50	0.03	0.17
10	Metronidazol	P01AB01	2.00	0.01	0.06
Total				17.92	100

Table 4 shows the pattern of antibiotic consumption. The total antibiotic usage was 17.92 DDD/100 bed days. Compared to our results, studies conducted at Kien An Hospital in Hai Phong and Military Central Hospital 108 found antimicrobial consumption to be lower with 7.0 and 7.1 DDD/100 bed days, respectively (Nguyen Thi Song Ha, 2022; Dang Thi Thuy et al., 2023). Nonetheless, our study was limited to patients aged 18 and older who underwent surgery, had length of hospital stay of at least 3 days, and met predefined exclusion criteria. In contrast, the two comparative studies included all patient antibiotic usage records during the study period such specific restrictions. In comparison to global studies on antibiotic use in orthopedic departments, the DDD/100 bed days observed in our study exceeds that reported in a study conducted in the hilly Hamalayan region of India , which documented a DDD/100 bed days of 12.34. However, it is lower than the values reported in studies conducted in Nanjing, China (DDD/100 bed days of 40 + 4) and Surabya, Indonesia (DDD/100 bed days of 74.18) (Ravi et al., 2021; Ma et al., 2016; Herawati et al., 2022). The DDD/100 bed days is a widely recognized method for quantifying antibiotic

consumption, facilitating comparisons of antimicrobial use across healthcare institutions at both national and international levels (Bhardwaj, 2018). Such comparisons contribute to increasing awareness among healthcare providers and enable the evaluation of antibiotic usage relative to other facilities. Additionally, this approach plays a crucial role in informing the formulation of healthcare policies designed to promote more rational and effective antibiotic stewardship.

A total of 10 antibiotics were utilized, with netilmicin being the most frequently prescribed agent, accounting for 5.23 DDD/100 bed days (29.19%). This was followed by ceftriaxone, with 4.89 DDD/100 bed days (27.29%), and cloxacillin at 4.35 DDD/bed days (24,27%). In comparison to study conducted at Nghe An Hospital for Traumatology and Orthopaedics, amoxicillin-clavulanat exhibited the highest DDD/100 bed days, at 11.2, followed by ceftriaxone with 8.9 DDD/100 bed days, and cephalothin with 7.9 DDD/100 bed days (Hoang Thi Khanh, 2018). In other countries, the studies reported varying results regarding the pattern of antibiotic usage and DDD/100 bed days. A study conducted in Palestine indicated that cephalothin was the most commonly used antibiotic, with a DDD/100 bed days of 50.30, followed by gentamicin (24.15) and ceftriaxone (17.35) (Masalma et al., 2024). In a separate study conducted in Indonesia, cefazolin was identified as the most frequently utilized antibiotic, exhibiting a DDD/100 bed days of 28.66, followed by cefixime, which recorded a DDD/100 bed days of 10.58 (Herawati et al., 2022). In our study, prophylactic antibiotics such as cefazolin were not utilized, whereas other antibiotics, including ceftriaxone and cloxacillin, were employed for both prophylactic and therapeutic purposes. Consequently, it should consider introducing recommended prophylactic antibiotics, such as cefazolin, specifically for use in orthopedic surgeries.

The beta-lactam class demonstrated the highest percentage of DDD/100 bed days, at 36.97%. The second highest percent accounted for aminoglycosides at 23.00%. Within the beta-lactams, third-generation cephalosporins (17.20%) constituted the largest share of DDD/100 bed days, followed by penicillins (15.96%), and second-generation cephalosporins (3.94%) (Table 5). The study conducted in Nghe An Hospital for Traumatology and Orthopaedics yielded the comparable results, indicating that beta-lactams represented the most substantial proportion at 67.3%. Furthermore, within the beta-lactams, penicillins accounted for the highest DDD/100 bed days (22.2%), closed followed by third-generation cephalosporins at 21.0% (Hoang Thi Khanh, 2018).

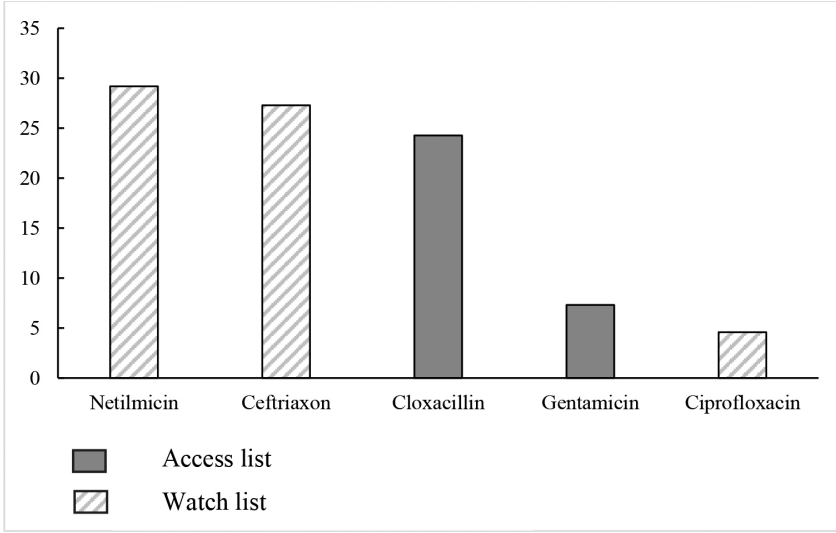

Figure 1. DU90% profile based on WHO AWaRe classification

According to the WHO AWaRe classification, among the 10 antibiotics used, four were classified as Access antibiotics (cloxacillin, oxacillin, gentamicin, and metronidazole), while six were classified under the Watch list (netilmicin, ceftriaxone, ciprofloxacin, cefamandole, cefuroxime, and vancomycin). Within the DU90% segment, five distinct agents were identified. Two of these agents, gentamicin and cloxacillin, belong to the Access list and together accounted for 31.58% of antibiotic consumption. The remaining three agents-netilmicin, ceftriaxon, and ciprofloxacin-are classified under the Watch list, collectively constituted 61.05% of antibiotic usage (Figure 1). Fewer antibiotics in the DU90% segment correspond to enhanced quality in

prescribing patterns. Compared to studies from other countries, our study indicated that the number of agents in the DU90% profile is lower than that observed in India (13 agents), but higher than that reported in Palestine (4 agents) (Thomas et al., 2022, Masalma et al., 2024). Furthermore, based on the WHO AWaRe policy, more than 60% of total antibiotic usage should be derived from the Access list (World Health Organization, 2023). However, our study shows that the antibiotics from the Access list comprised only 31.58% while those from the Watch list represented 61.05%. It is necessary to adjust the usage rate of antibiotics from the Watch list to mitigate antibiotic resistance and concurrently reduce treatment costs. The suggested approach is to replace netilmicin from the Watch list with gentamicin or amikacin from the Access list to increase the usage of antibiotics in the Access list while also reducing treatment costs.

Table 5. Antibiotic consumption by antibiotic class.

No.	Antibiotic class	DDD usage	DDD/100 bed days	Percentage (%)
1	Beta-lactams	2251.67	10.51	36.97
1.1	Second-generation cephalosporins	239.67	1.12	3.94
1.2	Third-generation cephalosporins	1047.00	4.89	17.20
1.3	Penicillins	965.00	4.51	15.86
2	Aminoglycosides	1400.57	6.54	23.00
3	Quinolones	175.25	0.82	2.88
4	Others	8.50	0.04	0.14
	Total		17.92	100

4. CONCLUSIONS

The study shows that antibiotics were primarily administered via injection, sourced domestically, and exclusively in generic form. Beta-lactams were the most consumed and commonly prescribed class of antibiotic. Netilmicin, ceftriaxone, and cloxacillin accounted for the highest DDD/100 bed days. Antibiotics classified under the Watch list still represented a significant proportion of the DU90% profile. Measures need to be implemented to enhance antibiotic usage from the Access list while replacing those from the Watch list to improve treatment cost-effectiveness and reduce antibiotic resistance.

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THỰC TRẠNG SỬ DỤNG KHÁNG SINH TẠI KHOA CHẤN THƯƠNG CHỈNH HÌNH, BỆNH VIỆN ĐA KHOA VÙNG TÂY NGUYÊN NĂM 2024

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TÓM TẮT

Việc sử dụng không hợp lý kháng sinh dẫn đến gia tăng tình trạng kháng kháng sinh đồng thời gia tăng chi phí và giảm hiệu quả điều trị bệnh. Nghiên cứu của chúng tôi tiến hành đánh giá thực trạng sử dụng kháng sinh ở khoa Chấn thương chỉnh hình, Bệnh viện đa khoa Vùng Tây Nguyên. Nghiên cứu được thực hiện với thiết kế mô tả cắt ngang trên các hồ sơ bệnh án của những bệnh nhân nội trú tại khoa Chấn thương chỉnh hình trong 6 tháng từ tháng 02/2024 đến tháng 7/2024. Nghiên cứu này sử dụng phương pháp ATC/DDD, chỉ số DU90% và hệ thống phân loại AWaRe của Tổ chức Y tế thế giới. Kết quả nghiên cứu cho thấy kháng sinh được dùng chủ yếu ở đường tiêm với 99,44% trong tổng giá trị sử dụng, kháng sinh được dùng 100% ở nhóm generic và thuốc sản xuất trong nước có tỉ lệ giá trị sử dụng cao (72,11%). Nhóm kháng sinh beta lactam có giá trị sử dụng cao nhất (chiếm 57,5% tổng giá trị sử dụng). DDD/100 ngày giường của các kháng sinh chiếm tỉ lệ cao nhất lần lượt là netilmicin (29,19%), ceftriaxon (27,29%) và cloxacillin (24,27%). Nhóm beta lactam và nhóm aminoglycosid có tỉ lệ DDD/100 ngày giường cao nhất với tỉ lệ 36,97% và 23,00%. Trong nhóm beta lactam, tỉ lệ DDD/100 ngày giường của cephalosporin thế hệ 3 có tỉ lệ lớn nhất (17,20%). Các kháng sinh nằm trong nhóm danh sách Tiếp cận theo chỉ số DU90% là gentamicin và cloxacillin chiếm tỉ lệ 31,58%, trong đó các kháng sinh nằm trong danh sách Theo dõi là netilmicin, ceftriaxon và ciprofloxacin chiếm tỉ lệ 61,06%.

Từ khóa: *Kháng sinh, Chấn thương chỉnh hình, ATC/DDD, DU90%, AWaRe.*

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