

## Analysis of Antibiotic Utilization at Son Tra District Health Center in 2024

Phân tích tình hình sử dụng kháng sinh tại Trung tâm Y tế Quận Sơn Trà năm 2024

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### Abstract

Antimicrobial resistance (AMR) has become a global challenge, particularly severe in developing countries due to antibiotic overuse and irrational use. Vietnam has implemented a national action plan to combat AMR, focusing on hospital antibiotic surveillance. This effort aims to optimize treatment outcomes, reduce healthcare costs, and improve the quality of care. However, at Son Tra District Health Center – a level II healthcare facility (before administrative merger) in Da Nang – no specific assessment has been conducted per Ministry of Health (MoH) criteria, despite the antibiotic consumption rate reaching 29.18% in 2024. The objective was to analyze the structure and level of antibiotic consumption at this center in 2024 according to the criteria of the Ministry of Health and the World Health Organization (WHO). A cross-sectional descriptive study was conducted using retrospective data from the hospital management software, including the list of pharmaceuticals and antibiotic consumption; data were processed and analyzed using Microsoft Excel. Results showed a total of 83 antibiotic items accounted for 29.18% of the total drug expenditure. The beta-lactam group represented 94.31% of antibiotic use, and domestic drugs accounted for 91.81%. The Defined Daily Dose per 100 bed-days (DDD/100 bed-days) was 190.1 (inpatients: 7.83%; outpatients: 2.04%). ABC/VEN analysis indicated that management efforts were concentrated on essential and vital medicines. Antibiotic use at the primary healthcare level was found to be rational, cost-effective, and safe, consistent with the local disease pattern. The results provide practical evidence to maintain the prioritization of domestic pharmaceuticals, strengthen control over beta-lactam antibiotic use, and expand periodic DDD-based surveillance. These actions contribute to the effective implementation of the National Action Plan on Combating Antimicrobial Resistance (issued under Decision No. 3465/QĐ-BYT).

**Keywords:** Antibiotic use, Son Tra District Health Center, 2024, drug management

### Tóm tắt

Tình trạng kháng kháng sinh đang trở thành thách thức toàn cầu, đặc biệt nghiêm trọng tại các quốc gia đang phát triển do lạm dụng và sử dụng thuốc không hợp lý. Việt Nam đã triển khai kế hoạch hành động quốc gia phòng chống

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kháng thuốc với trọng tâm là giám sát sử dụng kháng sinh trong bệnh viện. Hoạt động này nhằm tối ưu điều trị, giảm chi phí và nâng cao chất lượng chăm sóc. Tuy nhiên, tại Trung tâm Y tế Quận Sơn Trà – đơn vị hạng II (trước khi sát nhập) tại Đà Nẵng – hiện chưa có khảo sát cụ thể về thực trạng sử dụng kháng sinh theo tiêu chí Bộ Y tế, dù tỷ lệ sử dụng kháng sinh năm 2024 là 29,18%. Mục tiêu của nghiên cứu là phân tích cơ cấu và mức độ tiêu thụ kháng sinh tại Trung tâm Y tế Quận Sơn Trà năm 2024 theo tiêu chí Bộ Y tế và WHO. Nghiên cứu mô tả cắt ngang, hồi cứu dữ liệu danh mục thuốc và tiêu thụ kháng sinh từ phần mềm quản lý bệnh viện, xử lý bằng Excel. Kết quả cho thấy 83 khoản mục kháng sinh, chiếm 29,18% tổng giá trị thuốc; nhóm beta-lactam chiếm 94,31%, thuốc nội địa chiếm 91,81%; DDD/100 giường-ngày = 190,1 (nội trú: 7,83%; ngoại trú: 2,04%). Phân tích ABC/VEN cho thấy quản lý tập trung vào thuốc thiết yếu và quan trọng. Sử dụng kháng sinh tại tuyến cơ sở là hợp lý, tiết kiệm và an toàn, phù hợp mô hình bệnh tật. Kết quả cung cấp bằng chứng thực tiễn để duy trì ưu tiên thuốc nội, kiểm soát nhóm beta-lactam, mở rộng giám sát DDD định kỳ – góp phần thực hiện thành công Kế hoạch hành động quốc gia phòng, chống kháng thuốc (ban hành theo Quyết định số 3465/QĐ-BYT).

*Từ khóa:* sử dụng kháng sinh, Trung tâm Y tế Quận Sơn Trà, năm 2024, quản lý thuốc

## 1. Introduction

Antibiotics play a crucial role in treating infectious diseases; however, antimicrobial resistance has become an increasingly serious concern, particularly in developing countries, mainly due to inappropriate drug use [9].

In Vietnam, the Ministry of Health has implemented the National Action Plan on Antimicrobial Resistance, introducing various measures to regulate and monitor hospital antibiotic use [3].

Son Tra District Health Center, a grade II healthcare facility under the Da Nang Department of Health, reported an antibiotic utilization rate of 29.18% in 2024. Nevertheless, no comprehensive evaluation of antibiotic use at this institution has yet been conducted per the criteria established by the Ministry of Health. From this practical need, the study entitled “*Analysis of Antibiotic Utilization at Son Tra District Health Center in 2024*” was undertaken with the objectives of: (1) analyzing the pattern of antibiotic use, and (2) assessing the level of antibiotic consumption based on the Defined Daily Dose (DDD) indicator.

## 2. Methods

### 2.1. Study subjects

The study subjects included the list of antibiotics and the overall list of medicines used

at Son Tra District Health Center during the period from January to December 2024.

### 2.2. Study design

A cross-sectional descriptive study was conducted through retrospective data review related to the characteristics of the drug formulary and the antibiotics used at the Center in 2024.

### 2.3. Data collection and processing methods

Data were extracted from the Hospital Management Software and reports from the Planning and General Affairs Department, including: active ingredient name, trade name, concentration/dosage strength, route of administration, unit of measurement, quantity, unit price, total cost, number of outpatient visits, number of antibiotic prescriptions, and inpatient bed occupancy rate.

Inpatient denominator:  $\text{Bed-days} = \text{Number of actual hospital beds} \times \text{Bed occupancy rate (\%)} \times 365 \text{ days}$ .

Outpatient denominator:  $\text{Outpatient prescriptions} = \text{Total number of prescriptions containing at least one antibiotic during 2024}$ .

Drugs without ATC codes or without WHO-defined DDD values (Defined Daily Dose) according to the ATC/DDD 2024 index were excluded from the analysis.

Conversion of antibiotic consumption to DDDs:

$$\text{Total DDDs} = \frac{(\text{Total drug units} \times \text{Drug strength as per WHO DDD})}{\text{WHO DDD dose}}$$

$$\text{DDD/100 bed-days} = \frac{\text{Total DDDs} \times 100}{\text{Total beds} \times \text{Bed occupancy rate} \times 365}$$

$$\text{DDD/1,000 outpatient prescriptions} = \frac{\text{Total antibiotic units} \times 1,000}{(\text{Standard DDD} \times \text{Total outpatient visits})}$$

$$\text{Cost per DDD} = \frac{\text{Drug unit price} \times \text{Total quantity}}{\text{Total DDDs}}$$

### 3. Results

#### 3.1. Antibiotic utilization at Son Tra District Health Center in 2024

Table 1. Expenditure on antibiotic drugs

No.	Drug group	Drug items		Expenditure	
		Items	Proportion (%)	Expenditure (VND)	Proportion (%)
1	Antibiotics	83	18.36	5,703,264,214	29.18
2	Other medicines	369	81.64	13,850,244,129	70.82
<b>Total</b>		<b>452</b>	<b>100</b>	<b>19,553,508,343</b>	<b>100</b>

*Comment:* The analysis showed that in 2024, Son Tra District Health Center used 452 drug items, with an overall expenditure of VND 19,553,508,343. Among these, antibiotics accounted for 83 items (18.36% of the total), with an expenditure of VND 5,703,264,214, representing 29.18% of the Center’s total drug costs.

#### 3.2. Analysis of antibiotic groups at Son Tra District Health Center in 2024

Table 2. Expenditure by antibiotic group in 2024

No.	Antibiotic group	Drug items		Expenditure	
		Items	Proportion (%)	Expenditure (VND)	Proportion (%)
1	Aminoglycosides	7	8.43	138,741,270	2.43
2	Beta-lactams	45	54.22	5,378,771,268	94.31
3	Nitroimidazoles	9	10.84	46,097,800	0.81
4	Macrolides	9	10.84	61,045,276	1.07
5	Sulfonamides	2	2.41	11,562,600	0.20
6	Quinolones	10	12.05	66,750,000	1.17
7	Tetracyclines	1	1.20	296,000	0.01
<b>Total</b>		<b>83</b>	<b>100</b>	<b>5,703,264,214</b>	<b>100</b>

*Comment:* In 2024, the beta-lactam group at Son Tra District Health Center included 45 out of 83 antibiotic items, accounting for 54.22% of the total antibiotics. The expenditure for this group reached VND 5,378,771,268, representing 94.31% of the total cost of antibiotics. The quinolone group comprised 10 items, accounting for 12.05% of the total, with an expenditure of VND 66,750,000, corresponding to 1.17%. The nitroimidazole and macrolide groups contained 9 items each, representing 10.84%, spending VND 46,097,800 (0.81%) and VND 61,045,276 (1.07%), respectively. The tetracycline group included only 1 item, accounting for 1.20%, with an expenditure of VND 296,000, equivalent to 0.01%.

Table 3. Expenditure of the top five antibiotics.

No.	Drug name & strength	Subgroup	Active ingredient	Expenditure (VND)	Proportion (%)
1	Pyfacloer 250mg	2nd-gen Cephalosporin	Cefaclor monohydrat	1,265,920,000	22.19
2	Cepoxitil 100mg	3rd-gen Cephalosporin	Cefpodoxim	482,400,000	8.46
3	Cefaclor 250mg	2nd-gen Cephalosporin	Cefaclor	359,040,000	6.29
4	Cloxacillin 2g	Penicillin	Cloxacillin	312,000,000	5.47
5	Amoxicillin 500mg	Penicillin	Amoxicillin	307,720,000	5.40
Other antibiotics				2,976,184,214	52.19
<b>Total antibiotic expenditure</b>				<b>5,703,264,214</b>	<b>100</b>

*Comment:* At Son Tra District Health Center, the five antibiotics with the highest expenditure belonged to the  $\beta$ -lactam group. Among these, Pyfacloer 250 mg (cefaclor – second-generation cephalosporin) had the highest expenditure, amounting to VND 1,265,920,000, representing

22.19% of the total antibiotic expenditure. This was followed by Cepoxitil 100 mg (cefpodoxime – third-generation cephalosporin), with an expenditure of VND 482,400,000, accounting for 8.46%.

### 3.3. Origin of antibiotics used in 2024

Table 4. Expenditure on antibiotics by origin.

No.	Origin of drugs	Drug items		Expenditure	
		Items	Proportion (%)	Expenditure (VND)	Proportion (%)
1	Locally manufactured antibiotics	66	79.52	5,236,074,168	91.81
2	Imported antibiotics	17	20.48	467,190,046	8.19
<b>Total</b>		<b>83</b>	<b>100</b>	<b>5,703,264,214</b>	<b>100</b>

*Comment:* In 2024, Son Tra District Health Center predominantly used locally manufactured antibiotics, which accounted for 79.52% of the items and 91.81% of the

expenditure. Imported antibiotics represented only 20.48% of the items and 8.19% of the spending.

### 3.4. Expenditure on antibiotics by route of administration

Table 5. Expenditure on antibiotics by route of administration

No.	Route of administration	Drug items		Expenditure	
		Items	Proportion (%)	Expenditure (VND)	Proportion (%)
1	Parenteral (injection/infusion)	22	26.51	1,226,445,160	21.50
2	Oral administration	44	53.01	4,299,605,384	75.38
3	Other routes	17	20.48	177,213,670	3.12
<b>Total</b>		<b>83</b>	<b>100</b>	<b>5,703,264,214</b>	<b>100</b>

*Comment:* In 2024, oral antibiotics predominated at Son Tra District Health Center, with 44 items accounting for 53.01% of the total and an expenditure of VND 4,299,605,384, corresponding to 75.38%. In contrast, parenteral antibiotics included 22 items, representing 26.51% of the total, with an expenditure of VND 1,226,445,160, accounting for 21.50%.

### 3.5. Expenditure on antibiotics by single-component and multi-component formulations

Table 6. Distribution of antibiotics by number of items and expenditure according to formulation

No.	Formulation type	Drug items		Expenditure	
		Items	Proportion (%)	Expenditure (VND)	Proportion (%)
1	Single-component antibiotics	61	73.49	4,564,357,388	80.03
2	Multi-component antibiotics	22	26.51	1,138,906,826	19.97
<b>Total</b>		<b>83</b>	<b>100</b>	<b>5,703,264,214</b>	<b>100</b>

*Comment:* From Table 6, it can be observed that Son Tra District Health Center prioritized the use of single-component antibiotics, with 61 items accounting for 73.49% of the total and an expenditure of VND 4,564,357,388, corresponding to 80.03%.

### 3.6. ABC Analysis

Table 7. ABC Analysis of Antibiotic Consumption

No.	Category	Drug items		Expenditure	
		Items	Proportion (%)	Expenditure (VND)	Proportion (%)
1	Category A	15	18.07	4,367,881,656	76.54
2	Category B	20	24.10	997,860,890	17.50
3	Category C	48	57.83	337,521,668	5.96
<b>Total</b>		<b>83</b>	<b>100</b>	<b>5,703,264,214</b>	<b>100</b>

*Comment:* The ABC analysis conducted in 2024 at Son Tra District Health Center revealed that Category A included only 15 antibiotics, representing 18.07% of the total, but accounted for as much as 76.54% of the expenditure, equivalent to VND 4,367,881,656. Category B comprised 20 antibiotics, representing 24.10%

of the items, with an expenditure of VND 997,860,890, corresponding to 17.50%. Category C accounted for the most significant proportion of items, with 48 antibiotics representing 57.83% of the total, yet these contributed only 5.96% of the expenditure, equivalent to VND 337,521,668.

**3.7. VEN Analysis**

Table 8. Distribution of antibiotics according to VEN analysis

No.	Category	Drug items		Expenditure	
		Items	Proportion (%)	Expenditure (VND)	Proportion (%)
1	Vital (V)	4	4.82	111,362,060	1.95
2	Essential (E)	74	89.16	5,553,274,754	97.37
3	Non-essential (N)	5	6.02	38,627,400	0.68
<b>Total</b>		<b>83</b>	<b>100</b>	<b>5,703,264,214</b>	<b>100</b>

*Comment:* The VEN analysis 2024 at Son Tra District Health Center indicated that the Vital group included only 4 antibiotics, representing 4.82% of the total, with an expenditure of VND 111,362,060, corresponding to 1.95%. The Essential group accounted for the majority, with 74 antibiotics representing 89.16% of the items

and contributing 97.37% of the total expenditure. The Non-essential group included only 5 antibiotics, representing 6.02% of the items, with an expenditure of VND 38,627,400, corresponding to 0.68% of the total antibiotic expenditure.

**3.8. ABC/VEN matrix analysis**

Table 9. Distribution of antibiotics according to the ABC/VEN matrix analysis

Class	Category	Drug items		Expenditure	
		Items	Proportion (%)	Expenditure (VND)	Proportion (%)
Class A	V	0	0	0	0
	E	15	18.07	4,367,881,656	76.59
	N	0	0	0	0
Class B	V	1	1.20	72,709,560	1.28
	E	18	21.69	899,251,330	15.76
	N	1	1.20	25,900,000	0.45
Class C	V	3	3.61	38,652,500	0.68
	E	40	48.19	286,141,768	5.02
	N	5	6.02	12,727,400	0.22
<b>Total</b>		<b>83</b>	<b>100</b>	<b>5,703,264,214</b>	<b>100</b>

*Comment:* The results of the ABC/VEN matrix analysis in 2024 at Son Tra District Health Center demonstrated that Class A included only 15 antibiotics, all belonging to the Essential group, accounting for 18.07% of the items but up to 76.59% of the total expenditure. Class B consisted of 20 antibiotics, primarily

from the Essential group (21.69% of the items and 15.76% of the spending), with only a small proportion classified as Vital and Non-essential. Class C represented the most significant proportion in quantity (57.83%), but contributed a relatively low share of expenditure, mainly concentrated within the Essential group.

Table 10. Distribution of antibiotics according to the ABC/VEN matrix

No.	Group	Drug items		Expenditure	
		Items	Proportion (%)	Expenditure (VND)	Proportion (%)
1	Group I	19	22.89	4,479,243,716	78.51
2	Group II	59	71.08	1,211,293,098	21.23
3	Group III	5	6.02	12,727,400	0.26
<b>Total</b>		<b>83</b>	<b>100</b>	<b>5,703,264,214</b>	<b>100</b>

*Comment:* The I–II–III analysis revealed that Group I, despite accounting for only 22.89% of the items, represented the most significant proportion of expenditure, comprising 78.51% of the total

value. Group II included 71.08% of the items but contributed only 21.23% of the spending. Group III constituted a tiny proportion of quantity and value, with a negligible expenditure share.

### 3.9. Defined Daily Dose (DDD) of outpatient antibiotics at Son Tra District Health Center

Table 11. Total DDD of outpatient antibiotics

No.	Drug group	Drug items	
		Total DDD	Proportion (%)
1	Antibiotics	244,323	2.04
2	Other medicines	11,727,576	97.96
<b>Total</b>		<b>11,971,899</b>	<b>100</b>

*Comment:* In 2024, the total number of Defined Daily Doses (DDDs) for outpatient medications at Son Tra District Health Center was 11,971,899 DDDs. Among these,

antibiotics accounted for 244,323 DDDs, representing 2.04%, while other drugs accounted for 11,727,576 DDDs, corresponding to 97.96%.

### 3.10. Total DDD per 1,000 outpatient prescriptions for antibiotics

Table 12. Total DDD of outpatient antibiotics

No.	Antibiotic class	Total DDD	DDD per 1,000 outpatient prescriptions
1	Beta-lactams	241,325	1,028.4
2	Macrolides	1,219	5.2
3	Nitroimidazoles	1,238	5.3
4	Quinolones	507	2.2
5	Tetracyclines	34	0.1
<b>Total</b>		<b>244,323</b>	<b>1,041.2</b>

*Comment:* In 2024, the total outpatient antibiotic consumption at Son Tra District Health Center was 244,323 DDDs, corresponding to a utilization density of 1,041.2 DDDs per 1,000 prescriptions. Beta-lactams overwhelmingly dominated with 241,325 DDDs, equivalent to 1,028.4 DDDs per 1,000 prescriptions, accounting for nearly 99% of the

total consumption. Other antibiotic classes contributed only marginally: macrolides with 1,219 DDDs (5.2 DDDs per 1,000 prescriptions), nitroimidazoles with 1,238 DDDs (5.3 DDDs per 1,000 prescriptions), quinolones with 507 DDDs (2.2 DDDs per 1,000 prescriptions), and tetracyclines with 34 DDDs (0.1 DDDs per 1,000 prescriptions).

Table 13. DDD of outpatient beta-lactam antibiotics

No.	Antibiotic subclass	Total DDD	DDD per 1,000 outpatient prescriptions
1	Penicillins	79,101	337.1
2	Cephalosporins	1st generation	38,758
3		2nd generation	93,963
4		3rd generation	29,503
<b>Total</b>		<b>241,325</b>	<b>1,028.4</b>

*Comment:* Within the beta-lactam group of outpatient antibiotics used at Son Tra District Health Center in 2024, the total consumption reached 241,325 DDDs, corresponding to 1,028.4 DDDs per 1,000 prescriptions. Specifically: Penicillins accounted for 79,101 DDDs (337.1 DDDs per 1,000 prescriptions);

first-generation cephalosporins accounted for 38,758 DDDs (165.2 DDDs per 1,000 prescriptions); second-generation cephalosporins accounted for 93,963 DDDs (400.4 DDDs per 1,000 prescriptions); and third-generation cephalosporins accounted for 29,503 DDDs (125.7 DDDs per 1,000 prescriptions).

**3.11. DDD of inpatient antibiotics at Son Tra District Health Center**

Table 14. Total DDD of inpatient antibiotics

No.	Drug group	Drug items	
		Total DDD	Proportion (%)
1	Antibiotics	72,175	7.83
2	Other drugs	849,113	92.17
<b>Total</b>		<b>921,288</b>	<b>100</b>

*Comment:* In 2024, the total number of inpatient Defined Daily Doses (DDD) at Son Tra District Health Center was 921,288. Among these, the group of antibiotics accounted for

72,175 doses, representing 7.83%, while the remaining 849,113 doses, equivalent to 92.17%, were from other medications.

**3.12. Total DDD per 100 bed-days for inpatient antibiotics**

Table 15. Total DDD of inpatient antibiotics

No.	Antibiotic class	Total DDD	DDD per 100 bed-days
1	Beta-lactams	56,368	148.5
2	Aminoglycosides	479	1.3
3	Macrolides	9,596	25.3

No.	Antibiotic class	Total DDD	DDD per 100 bed-days
4	Nitroimidazoles	1,047	2.8
5	Quinolones	4,524	11.9
6	Tetracyclines	162	0.4
<b>Total</b>		<b>72,175</b>	<b>190.1</b>

*Comment:* In 2024, the total inpatient antibiotic consumption at Son Tra District Health Center was 72,175 Defined Daily Doses (DDD), corresponding to a utilization density of 190.1 DDD per 100 bed-days. Within this, the beta-lactam group accounted for the most significant proportion, with 56,368 DDD, equivalent to 148.5 DDD per 100 bed-days. The other antibiotic groups were used at much lower

proportions, including aminoglycosides with 479 DDD, equivalent to 1.3 DDD per 100 bed-days, macrolides with 9,596 DDD, equivalent to 25.3 DDD per 100 bed-days, nitroimidazoles with 1,047 DDD, equivalent to 2.8 DDD per 100 bed-days, quinolones with 4,524 DDD, equivalent to 11.9 DDD per 100 bed-days, and tetracyclines with 162 DDD, equivalent to 0.4 DDD per 100 bed-days.

Table 16. DDD of inpatient beta-lactam antibiotics

No.	Antibiotic subclass	Total DDD	DDD per 100 bed-days
1	Penicillins	30,033	79.1
2	Cephalosporins	1st generation	66
3		2nd generation	15,771
4		3rd generation	10,497
<b>Total</b>		<b>56,368</b>	<b>148.5</b>

*Comment:* In the beta-lactam antibiotic group used for inpatients at Son Tra District Health Center in 2024, the total number was 56,368 Defined Daily Doses (DDD), corresponding to 148.5 DDD per 100 bed-days. Within this group, penicillins accounted for the highest proportion, with 30,033 DDD, equivalent to 79.1 DDD per 100 bed-days, followed by second-generation cephalosporins with 15,771 DDD, equivalent to 41.5 DDD per 100 bed-days, and third-generation cephalosporins with 10,497 DDD, equivalent to 27.7 DDD per 100 bed-days. The first-generation cephalosporins were used the least, with 66 DDD, equivalent to 0.2 DDD per 100 bed-days.

#### 4. Discussion

##### 4.1. Antibiotic utilization at Son Tra District Health Center in 2024

In 2024, Son Tra District Health Center utilized 452 pharmaceutical items with a total value of VND19,553,508,343, of which antibiotics accounted for 18.36% of the total items and 29.18% of the total value (5,703,264,214 VND). These figures indicate that the management of medicines at the institution was appropriately controlled and did not exceed the warning threshold. When compared with the study at Vinh Thuan General Hospital, where antibiotics accounted for 13.36% of items and 27.32% of the total value [12], the level of antibiotic utilization at Son Tra District Health Center appears consistent and appropriate for the characteristics of a district-level healthcare facility. However, the difference in the proportion of antibiotic expenditure compared with Pham Ngoc Thach

Hospital (39.3%) [10] is mainly attributable to variations in disease profiles. Overall, Son Tra District Health Center has maintained a rational level of antibiotic utilization, balancing effectiveness with cost efficiency.

#### **4.2. Analysis of antibiotic groups at Son Tra District Health Center in 2024**

In 2024, at Son Tra District Health Center, beta-lactams dominated the number of items and the expenditure on antibiotics. This group comprised 45 items (54.22%) but accounted for as much as 94.31% of the total antibiotic expenditure (VND 5,378,771,268). Other groups, such as quinolones, macrolides, and nitroimidazoles, represented only a small proportion. This trend is consistent with findings from many district-level studies: at Vinh Thuan General Hospital (Kien Giang), beta-lactams accounted for 50% of items and 86.87% of the value [12]. At the same time, in Thuan An town (Binh Duong), the corresponding figures were 61.86% and 79.15% [16]. Notably, the top five antibiotics with the highest expenditure in 2024 all belonged to the beta-lactam group: Pyfactor 250 mg (Cefaclor) with a cost of VND 1,265,920,000, accounting for 22.19%; Cepoxitil 100 mg (Cefpodoxime) with VND 482,400,000 (8.46%); Cefaclor 250 mg with VND 359,040,000 (6.29%); Cloxacillin 2 g with VND 312,000,000 (5.47%); and Amoxicillin 500 mg with VND 307,720,000 (5.40%). Among these, second- and third-generation cephalosporins account for a large proportion of the population. This result is also consistent with global trends: Klein et al. (2024) [8] reported that broad-spectrum penicillins and cephalosporins were the most widely used antibiotics during 2016–2023, particularly in low- and middle-income countries.

#### **4.3. Origin of antibiotics used in 2024**

In 2024, in response to the national campaign “Vietnamese people prioritize using Vietnamese medicines” [4], Son Tra District Health Center achieved a remarkably high proportion of domestically produced antibiotics: 66 items (79.52%) with a total value of VND 5,236,074,168 (91.81%). In contrast, imported antibiotics accounted for only 20.48% of items and 8.19% of the total expenditure, primarily reserved for exceptional treatment cases. This proportion was higher than that reported at Vinh Thuan General Hospital (85.13%) [12]. It showed a clear difference compared with higher-level hospitals such as Pham Ngoc Thach Hospital (76.2%) [10] and Nhan Dan 115 Hospital (56.8%) [15]. This achievement not only aligns with the national policy but also contributes to cost savings, ensures a stable supply of medicines, and enhances the role of domestic pharmaceuticals in clinical practice.

#### **4.4. Expenditure on antibiotics by route of administration**

In 2024, oral antibiotics predominated at Son Tra District Health Center, accounting for 44 items (53.01%) and a value of VND 4,299,605,384 (75.38%). This pattern reflects a cost-effective and safe treatment strategy consistent with the Ministry of Health’s recommendation to prioritize oral administration at the primary care level [2]. Conversely, parenteral antibiotics comprised only 22 items (26.51%) and 21.50% of expenditure, tightly regulated to minimize risks of complications and reduce costs. Compared with findings at Vinh Thuan General Hospital (65.77%) [12] and the high rate of injectable antibiotic overuse at Nhan Dan 115 Hospital (64.9%) [15], the results at Son Tra District Health Center indicate rational regimen selection. This practice contributes to

improved treatment outcomes, enhances patient experience, and supports the national antimicrobial resistance prevention and control strategy.

#### **4.5. Expenditure on antibiotics by single-component and multi-component formulations**

According to Circular 21/2013/TT-BYT (Ministry of Health, 2013) [1], fixed-dose combination antibiotics should only be used when there is evidence of superior efficacy and safety. At Son Tra District Health Center in 2024, single-component antibiotics accounted for 73.49% of items and 80.03% of the total expenditure, reflecting a controlled and rational approach in drug selection. Compared with the findings at Vinh Thuan General Hospital (Tran Thanh Trung, 2020) [12], this proportion was lower but demonstrated a balanced strategy in which combinations were prescribed only when clinically necessary. This policy improves treatment effectiveness, cost savings, and reduces antimicrobial resistance.

#### **4.6. ABC analysis**

The ABC analysis conducted in 2024 at Son Tra District Health Center revealed that Group A represented only 18.07% of items (15 drugs) but accounted for as much as 76.54% of the total expenditure (VND 4,367,881,656). This group plays a pivotal role and therefore requires strict management. Group B included 20 drugs (24.10%) with 17.50% of expenditure, while Group C, the largest group with 48 drugs (57.83%), represented only 5.96% of expenditure and could be managed more flexibly. This structure is consistent with the recommendations of Circular 21/2013/TT-BYT [1], reflecting rational budget allocation by prioritizing close monitoring of essential high-cost medicines—particularly beta-lactam antibiotics such as Cefaclor—while encouraging the use of generic domestic drugs to reduce costs.

#### **4.7. VEN analysis**

The VEN analysis at Son Tra District Health Center in 2024 showed that the distribution of antibiotics according to priority levels was rational. The Vital group accounted for only 4.82% of items and 1.95% of expenditure (VND 111,362,060) but played a crucial role in emergency care, necessitating strict management and stockpiling. The Essential group predominated with 74 drugs (89.16%) and 97.37% of expenditure, forming the cornerstone of treatment for common diseases and reflecting rational, safe, and cost-effective selection. The Non-essential group included 5 drugs (6.02%) with 0.68% of expenditure, maintained to meet the needs of less common conditions but requiring flexible management to prevent unnecessary stockpiling and waste.

#### **4.8. ABC/VEN matrix analysis**

The ABC/VEN matrix analysis in 2024 at Son Tra District Health Center demonstrated that antibiotic management was implemented strictly and focused. The results showed no medicines categorized as AN—non-essential drugs with high expenditure—and only 1 drug classified as BN and 5 drugs as CN (accounting for 0.26% of total spending), reflecting effective control over non-essential medicines. Based on priority levels, Category I included 19 drugs (22.89%) but accounted for as much as 78.51% of total expenditure (VND 4,479,243,716), representing the key group requiring close monitoring in terms of procurement and stock management. Category II comprised 59 drugs (71.08%), accounting for 21.23% of expenditure, and was subject to intermediate-level management, while Category III included 5 drugs (6.02%) with a very low expenditure share (0.26%). This structure indicates that the center has prioritized its budget toward essential medicines while minimizing unnecessary drugs, thereby enhancing treatment effectiveness,

ensuring patient safety, and supporting the sustainable use of healthcare resources.

#### **4.9. Defined Daily Dose (DDD) of outpatient antibiotics at Son Tra District Health Center**

The defined daily dose (DDD) analysis in 2024 at Son Tra District Health Center recorded 11,971,899 DDD of outpatient medicines, of which antibiotics accounted for only 244,323 DDD (2.04%). This proportion reflects rational prescribing practices and effective restriction of antibiotic overuse. According to the U.S. Centers for Disease Control and Prevention (2024) [5], effective antibiotic stewardship at the primary healthcare level is a key strategy in combating antimicrobial resistance. Similarly, the study by Vu Minh et al. (2024) [14] emphasized that rational antibiotic prescribing is achievable when accompanied by prescriber training, guideline-based prescribing, and rigorous monitoring.

#### **4.10. Total DDD per 1,000 outpatient prescriptions for antibiotics**

The analysis of DDD per 1,000 outpatient prescriptions revealed that beta-lactams were the most frequently used antibiotic group at Son Tra District Health Center in 2024, with 241,325 DDD corresponding to 1,028.4 DDD per 1,000 prescriptions. Other groups, such as nitroimidazoles, macrolides, quinolones, and tetracyclines, accounted for only a tiny proportion, each below 6 DDD per 1,000 prescriptions. This finding is consistent with the study by Ha Thi Hoang Le (2022) [6] at Viet Tri Construction Hospital, which emphasized that beta-lactams are the preferred choice for outpatient treatment due to their broad spectrum of activity and favorable safety profile. Furthermore, this trend reflects compliance with the World Health Organization (2021) [17] recommendations, which encourage prioritizing and closely monitoring the use of the beta-

lactams to mitigate antimicrobial resistance. Within the beta-lactam group, second-generation cephalosporins had the highest proportion (93,963 DDD; 400.4 DDD per 1,000 prescriptions), followed by penicillins (79,101 DDD; 337.1 DDD per 1,000 prescriptions). The studies of Nguyen Thi Thuy (2020) [11] and Pham Minh Tuan et al. (2023) [13] also reported that second-generation cephalosporins are the most commonly prescribed group at the primary healthcare level, whereas penicillins remain recommended for mild infections. First-generation cephalosporins were specified at a moderate level (165.2 DDD per 1,000 prescriptions), while third-generation cephalosporins—classified in the “Watch” category by WHO (2023) [18]—were strictly controlled (125.7 DDD per 1,000 prescriptions). This prescribing pattern demonstrates a rational strategy that balances treatment effectiveness with minimizing the risk of antimicrobial resistance.

#### **4.11. DDD of inpatient antibiotics at Son Tra District Health Center**

Table 14 shows that in 2024, the total defined daily dose of inpatient antibiotics at Son Tra District Health Center reached 72,175 DDD, accounting for 7.83% of the total 921,288 DDD for all medicines. This relatively low proportion reflects that inpatient antibiotic use was well controlled. Conversely, the remaining 92.17% of DDD was attributed to other therapeutic drug classes, indicating a diverse and rational inpatient treatment profile. This structure confirms that the center’s antibiotic management policy has been implemented correctly, balancing treatment needs with strict stewardship. As a result, it contributes to reducing the risk of antimicrobial resistance, saving costs, and improving the quality of patient care.

#### **4.12. Total DDD per 100 bed-days for inpatient antibiotics**

In 2024, the total inpatient antibiotic consumption at Son Tra District Health Center amounted to 72,175 DDD, equivalent to 190.1 DDD per 100 bed-days. This represents a relatively high utilization level, appropriate to the characteristics of inpatient care. Beta-lactams accounted for 78% of this use (56,368 DDD; 148.5 DDD per 100 bed-days), underscoring their dominant role in infection control. This pattern is consistent with studies at the primary care level conducted by Tran Thanh Trung (2020) [12], Vu Thi Tuyet Nhung (2020) [15], and Nguyen Thi Thuy (2020) [11]. Within the beta-lactam group, penicillins were the most frequently used, with 30,033 DDD (79.1 DDD per 100 bed-days), reflecting a preference for narrow-spectrum antibiotics that are cost-effective and safe. This finding aligns with the report by Ha Thi Hoang Le (2022) [6], where penicillins surpassed cephalosporins to become the primary choice. Second- and third-generation cephalosporins reached 41.5 and 27.7 DDD per 100 bed-days, respectively. In contrast, at Phu Tho Pulmonary Hospital, cephalosporins remained the predominant group (Hoang Van Thieu, 2022) [7], highlighting variations in antibiotic patterns depending on disease burden at different healthcare facilities.

#### **4.13. Limitations and directions for future research**

##### **a. Limitations**

The present study was a retrospective cross-sectional descriptive analysis conducted over one year; therefore, several inherent limitations should be acknowledged.

First, the WHO (2023) AWaRe (Access–Watch–Reserve) classification framework was not applied to categorize the 83 identified antimicrobial agents, although third-generation cephalosporins (Watch group) accounted for a

considerable proportion (125.7 DDD per 1,000 outpatient prescriptions).

Second, the population-based indicator **DID** (Defined Daily Doses per 1,000 inhabitants per day) could not be calculated due to the lack of accurate demographic data for Son Tra District (estimated population of approximately 180,000).

Third, the study did not include clinical stewardship indicators such as the IV-to-PO switch rate, duration of therapy, or de-escalation rate. Moreover, the data covered only the year 2024, which limits the ability to assess quarterly or pre–post intervention trends.

##### **b. Future directions**

Future studies may consider expanding the scope of investigation in several directions:

(1) Collecting multi-year data (e.g., 2024–2026) to analyze antibiotic utilization trends and construct AWaRe-based surveillance metrics (according to WHO classification).

(2) Collaborating with the Da Nang Social Security Agency to estimate the actual DID and compare it with national or international benchmarks.

(3) Examining key stewardship indicators, such as the IV-to-PO switch rate in Internal Medicine and Pediatrics departments.

## **5. Conclusion**

In 2024, Son Tra District Health Center utilized 83 antibiotic items, accounting for 18.36% of the total number and 29.18% of the total value of medicines. Beta-lactams played a central role, representing over half of the items and 94.31% of the total expenditure. The five antibiotics with the highest costs belonged to this group, notably Pyfaclo 250 mg (22%) and Cepoxitil 100 mg (8.46%). Domestic antibiotics predominated, comprising 79.52% of items and 91.81% of expenditure. Oral formulations were used more frequently than injectables.

ABC/VEN analysis revealed that expenditure was primarily concentrated in groups A and I, while the remaining groups accounted for smaller proportions, reflecting a focused and rational management strategy.

Regarding consumption, outpatient antibiotics represented only 2.04% of the total defined daily doses (DDD), with beta-lactams ranking first (1,028.4 DDD per 1,000 prescriptions). Inpatient antibiotics accounted for 7.83% of the total DDD, dominated by beta-lactams (78%), followed by macrolides and quinolones, while specialized groups were tightly controlled. The index of 190.1 DDD per 100 bed-days reflects a rational level of use in line with treatment requirements at the district level.

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