

# Antibiotic prescribing in Slovenia in 2014 and differences between Slovenian regions and EU member countries

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**Abstract—Background—**The goal of the present research was to investigate how and to what extent Slovenian regions differentiate in the quantity and type of antibiotics prescribed, and also to examine the differences in the frequency of prescribing antibiotics between Slovenia and other EU member countries.

**Methods—**The data used in the research, namely the prescriptions for antibiotics and broad-spectrum antibiotics, was collected from Zavod za zdravstveno zavarovanje Slovenije (ZZZS). The method used was retrospective analysis of prescription data in primary practice in Slovenia in 2014. The observed variable for the analysis of the prescribing of antibiotics on an outpatient basis was DDD per 1000 recipients. DDD (Defined Daily Dose) is an average daily dose used for the main indication in adult patients.

**Results—**A total of 1324 primary practice doctors from all Slovenian regions participated in the study. There is a statistically relevant difference in the quantity of prescribed antibiotics between Slovenian regions. In the Ljubljana region, more antibiotics are being prescribed and in Maribor region, less antibiotics are being prescribed compared to the Slovenian average. Also, there is a statistically relevant difference in the frequency of prescribing of broad-spectrum antibiotics between different regions in Slovenia: more broad-spectrum antibiotics are being prescribed in the Ljubljana region, whereas in the Maribor, Murska Sobota and Novo mesto regions, less broad-spectrum antibiotics are being prescribed in comparison to the Slovenian average. In other EU countries, more broad-spectrum antibiotics are being prescribed than in Slovenia.

**Conclusion—**In Slovenia, the frequency of prescribing broad-spectrum antibiotics is lower in comparison to other EU member countries. There is a statistically important difference in the frequency of prescribing of broad-spectrum antibiotics between Slovenian regions, and, therefore, it would be necessary to further examine the reasons for these differences and consequently make oriented efforts to reduce them.

**Index Terms—**Antibiotic prescribing, differences in antibiotic prescribing, antibiotic therapy

## I. INTRODUCTION

Antibiotics are substances of microbial origin which, in small amounts, inhibit the growth of other microbes or destroy them. The name comes from the Greek anti (against) and bios (life). Mostly, we use the word antibiotic for all substances of all origins which can inhibit or kill bacteria. It would be better to use the word antimicrobial which denotes a substance that acts against all microorganisms and does no harm to humans.

The first written source in which antimicrobials were mentioned was the Ebers Papyrus from 1550 BC. The first invention that led to the synthesis of a drug dates back to 1910. Paul Ehrlich synthesized arsphenamine (used to treat syphilis) at the six hundred and sixth attempt. In 1928, Alexander Fleming accidentally discovered penicillin. Howard Florey and Ernst Boris Chain were able to extract and purify penicillin in a larger quantity, which led to its commercial use in 1942. It was considered as a wonder drug because of its effectiveness. Fleming, Florey and Chain received a Nobel Prize for their discoveries in 1945. In 1945, Fleming warned about antibiotic resistance which emerged from the overuse of antibiotics [1].

## II. MATERIAL AND METHODS

In my research, I tried to determine how and to what extent Slovenian regions differ in the quantity and type of antibiotics prescribed. Primary practice doctors from all Slovenian regions participated in my research. The data was collected from January to December of 2014 by the Zavod za zdravstveno zavarovanje Slovenije (ZZZS). The data was the number of all prescribed antibiotics and the number of broad-spectrum antibiotics. DDD (Defined Daily Dose) is the assumed average maintenance dose per day for a drug used for its main indication in adults. It is a cross-sectional study and it was analyzed in the SPSS program.

## III. RESULTS

The sample comprised 1324 primary practice doctors from all Slovenian regions in 2014. The data showed that DDD of antibiotics per 1000 recipients prescribed in Slovenia of 12.4. Of that, DDD of broad-spectrum antibiotics prescribed per

1000 recipients was 9.3. In EU member countries, there 18.6 DDD of broad-spectrum antibiotics were prescribed per 1000 recipients.

There were statistically significant differences among the different Slovenian regions. More antibiotics were prescribed in the Ljubljana region and less in the Maribor region.

Table I: Dependence of DDD antibiotics/1000 recipients per each OE ZZZS

REGION	Average of prescribed DDD antibiotics per 1000 recipients (each OE versus other OE)	t-score	P score
OE Celje	12.0 ± 3.2 vs. 12,4 ± 4,2	-1.186	0.236
OE Koper	12.7 ± 2.9 vs. 12,4 ± 4,2	0.824	0.410
OE Krško	11.7 ± 2.2 vs. 12.4 ± 4.2	-1.155	0.248
OE Kranj	12.6 ± 2.6 vs. 12.4 ± 4.2	0.435	0.664
OE Ljubljana	12.8 ± 3.8 vs. 12.2 ± 4.2	2.628	0.01
OE Maribor	11.4 ± 2.7 vs. 12.6 ± 4.3	-3.904	<0.001
OE Murska Sobota	11.8 ± 2.4 vs. 12.5 ± 4.2	-1.274	0.203
OE Nova Gorica	13.1 ± 9.3 vs. 12.4 ± 3.6	1.419	0.160
OE Novo mesto	12.7 ± 5.0 vs. 12.4 ± 4.0	0.567	0.571
OE Ravne na Koroškem	12.9 ± 6.1 vs. 12.4 ± 3.9	1.093	0.27

#### IV. DISCUSSION

Through my research, I discovered that there 12.4 DDD of antibiotics were prescribed per 1000 recipients in 2014. There were statistically relevant differences among the Slovenian regions. In the Ljubljana region, more antibiotics were prescribed and in the Maribor region, less antibiotics were prescribed.

Some Slovenian regions differed in broad-spectrum antibiotics prescribed. More broad-spectrum antibiotics were prescribed in the Ljubljana and Koper regions and less in the Maribor, Murska Sobota in Novo mesto regions. There were less broad-spectrum antibiotics prescribed in Slovenia than in other EU countries.

My research results partially match other researchers' results. Antibiotics are less prescribed in the East and North. The data match for Maribor and Murska Sobota which lie in the northern part of Slovenia and do not match for Novo mesto which lies in the southern part of Slovenia [2].

We know from studies that less antibiotics are prescribed in countries with appointments in primary care services, more antibiotics registered on the market, with restrictions in antibiotics marketing, higher educational status, less religious people, more unemployment and higher population density [3].

Table II: Broad spectrum antibiotics in Slovenian regions

REGION	Broad spectrum antibiotics in Slovenian regions (each OE versus other OE)	t-score	P-score
OE Celje	8.4 ± 8.9 vs. 9.4 ± 8.2	-1.171	0.242
OE Koper	11.4 ± 9.0 vs. 9.1 ± 8.2	2.691	0.007
OE Krško	8.2 ± 6.3 vs. 9.3 ± 8.3	-0.895	0.371
OE Kranj	8.5 ± 5.9 vs. 9.4 ± 8.5	-1.160	0.246
OE Ljubljana	11.5 ± 8.9 vs. 8.3 ± 7.8	6.456	<0.001
OE Maribor	7.5 ± 8.7 vs. 9.6 ± 8.2	-3.393	<0.001
OE Murska Sobota	6.3 ± 6.1 vs. 9.5 ± 8.4	-3.076	<0.001
OE Nova Gorica	9.3 ± 8.4 vs. 9.3 ± 8.3	0.002	0.999
OE Novo mesto	6.3 ± 3.6 vs. 9.5 ± 8.4	-3.005	<0.001
OE Ravne na Koroškem	8.5 ± 7.5 vs. 9.4 ± 8.3	-0.914	0.361

There is still from 25 to 68% suboptimal use of antibiotics. The main purpose of rational use of antibiotics is to treat a bacterial infection with the most efficient antibiotic with minimum side effects, minimal costs and which are least

capable of inducing resistance [4]. Less antibiotics are prescribed with a stricter prescribing policy. Even computer programs for choosing an appropriate antibiotic and

educational programs were helpful with more rational prescribing [5], [6], [7].

The doctors prefer broad-spectrum antibiotic in more ill and elderly patients to gain quicker and efficient resolution of illness and perhaps delay hospitalization. All the doctors who participated explained their choices to do the best for their patients and the community [8].

The most efficient measure in more optimal prescribing is education of doctors, patients and the community through different means and forms (leaflets, public announcements, TV, social media...). Each situation requires an individual approach. Interactive didactical seminars are more effective than lectures. Patients benefit from delayed prescribing, which means that the patient does not receive an antibiotic for an infection of upper respiratory tract (most often caused by viruses) on the initial visit but only in case of complications [9].

We have a national strategy to optimize the use of antibiotics and lower antimicrobial resistance in human and veterinary use. Slovenia should reduce antibiotic prescribing by 25%, reduce antibiotic treatment in upper respiratory tract infections, improve the structure of antibiotic prescribing in favour of narrow-spectrum antibiotics, collect and analyze of antibiotic prescribing data, and give feedback to prescribers. There should be prompt and simple guidelines for antibiotic use. We should also stop treatment with leftover antibiotics (there sometimes is a discrepancy between prescribed and given doses of antibiotics) [10].

In my research, I discovered that there are some differences among the Slovenian regions in antibiotic prescribing. We could give prescribers feedback on their antibiotic prescribing and provide them with a comparison with other prescribers. Another option is the introduction of a clinical pharmacist. Also, guidelines for prescribing antibiotics in primary care could be developed.

The limitation of my research is that I have only focused on the data of prescribed antibiotics. I did not collect the factors that could affect prescribing, such as physicians' and practices' characteristics. In further research, there could be an emphasis on what the factors are which contribute to differences in prescribing in order to improve prescribing.

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