

RESEARCH STUDIES

Evaluation of Beta-lactam antibacterials and penicillins consumption

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Abstract

Background: The beta-lactam family of antibiotics includes the majority of the most heavily used antibacterials in clinical medicine. They are important, both historically and currently, because of their effectiveness and generally low toxicity. All around the world in hospitals consumption recorded in medium 30-50% of all antibiotics and that situation determined higher attention for dynamic use study of beta-lactam antibacterials and penicillins in hospitals.

Material and methods: For this study we used data of a six-year (2009-2014) period, in the Emergency Medicine Institute and their subdivisions with the highest consumption of antibiotics which shows the dynamics of the use of beta-lactam antibacterials and penicillins in grams and value indexes.

Results: In the evaluated period consumption of beta-lactam antibacterials and penicillins in EMI recorded a decline from 85.5 to 20.8 DDD/1000 or by 75.67%, in ICD departments from 367.92 to 133.91 DDD/1000 or by 63.60%, and respectively from 74.48 to 39.31 DDD/1000 in SSOTD or by 19.84%. Medium annual consumption in EMI recorded 65.42 DDD/1000 and respectively in ICD 178.29 and 73.68 DDD/1000 in SSOTD departments, while in international hospitals medium consumption constitutes 354.3 and in ICU 575 DDD/1000. In 2014 ICD departments recorded 6549.28 lei per DDD/1000 that was by 6.12 times more than the cost of 1069.62 lei registered in SSOTD departments and by 11.49 times than 569.84 lei recorded per DDD/1000 in all EMI.

Conclusions: In the evaluated period, EMI recorded the consumption of beta-lactam antibacterials and penicillins by 5.42 times less comparatively to 354.3 DDD/1000 registered in some international hospitals, which could be considered an important point for reviewing antimicrobial treatment of the hospitalized patients, as well as annual planning optimization and rational use of this group and all antibiotics necessities.

Key words: Beta-lactam antibacterials, penicillins, defined daily dose, consumption, hospitals.

Introduction

The beta-lactam antibacterials and penicillins remain the most heavily used antibacterials in clinical medicine. They are important, both historically and currently, because of their effectiveness and generally low toxicity. The international market of consumption of beta lactam antibiotics amounts annual sales of about US \$15 billion and it makes up to 65% of the total antibiotics market. The annual consumption is estimated to be in the range of 10–30 million tons and this is increasing with time [1, 2]. All around the world in hospitals consumption of beta-lactam and penicillin antibiotics recorded on average 30-50% of all antibacterials. That situation determined a higher attention for this group of anti-infectives for systemic use in medicine [3, 4, 5, 6, 7, 8] and supposed to take priority in EMI, including surveillance, stringent use control and rational prescription, as well as supporting the importance of antimicrobial consumption [9, 10, 11].

The primary aim of the study was to evaluate institutional representative data on beta-lactam antibacterials and penicillins utilization in accordance with the World Health Organization (WHO) requirements, directed to determine the value of Defined Daily Doses per 1000 Occupied-Bed Days (DDD/1000) and value cost in dynamics per institution and most important departments [12].

Material and methods

For this study we used the data of a six-year (2010-2014) period, DDD/1000 consumption of beta-lactam and penicillin antibiotics in EMI (Emergency Medicine Institute) and their main subdivisions such as ICD (reanimation, intensive therapy and intensive neurological "stroke" departments) and SSOTD (septic surgical and septic orthotraumatology departments) [13], which shows the dynamics of consumption of anti-infectives for systemic use drugs, as classified by Anatomical Therapeutic Chemical (ATC), classification system of World Health Organization (WHO) indicated, in g (grams) and lei (value indexes). Statistical, analytical, mathematical, comparative, logical and descriptive were used as the methods of study.

Results and discussion

For determining the number of DDD/1000 we used data about total annual consumption of beta-lactam antibacterials and penicillins and the statistics data concerning the number of treated patients (only patients with health insurance and other free treated by the state categories of citizens). The total number of occupied bed/days in the institution was 188762 in 2009, 191556 in 2010, 186246 in 2011, 199816 in 2012, 193019 in 2013 and 187558 in 2014, and respectively for the corresponding departments of

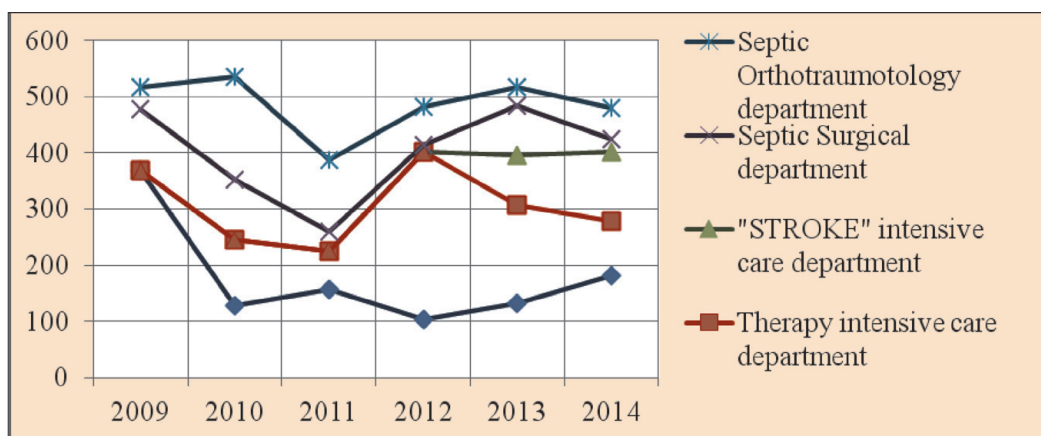


Fig. 1. Total beta-lactam antibacterials and penicillins consumption in DDD/1000 during 2009–2014.

EMI: reanimation (2009 = 3990; 2010 = 6551; 2011 = 6985; 2012 = 9051; 2013 = 7384; 2014 = 7361), intensive therapy (2010 = 2922; 2011 = 3327; 2012 = 3239; 2013 = 3407; 2014 = 3388), intensive neurological “stroke” (2013 = 2553; 2014 = 4193), septic surgical (2009 = 14030; 2010 = 14212; 2011 = 12875; 2012 = 12372; 2013 = 12464; 2014 = 12104), septic orthopedic-traumatology (2009 = 10664; 2010 = 10017; 2011 = 9540; 2012 = 10178; 2013 = 9701; 2014 = 9535) [14, 15, 16, 17].

Consumption of beta-lactam antibacterials and penicillins is characterised by the use of beta-lactam antibacterials and penicillins parenteral (P) and enteral (E) forms with DDD 2.0(P) and 2.0(E) for ampicillinum, with DDD 1.0(P) and 1.0(E) for amoxicillinum, with DDD 3.0(P) and 1.0(E) for amoxicillinum+ acidum clavulan ICDm, with DDD 15.0(P) for ticarcillinum. Total beta-lactam antibacterials and penicillins consumption in DDD/1000 during 2009-2014 is shown in figure 1.

From figure 1, it can be observed a total decrease of consumption in the group of beta-lactam antibacterials and penicillins from 516.88 in 2009 to 385.61 DDD/1000 in 2014 or by 25.40%. According to the annual medium consumption of 562.51 DDD/1000 could be placed as

follows: first – reanimation department with 178.08 DDD/1000 or 31.66%, second – intensive therapy department with 131.82 DDD/1000 or 23.43%, third – intensive neurological «stroke» department with 105.25 DDD/1000 or 18.71%, fourth – septic orthotraumatology department with 84.37 DDD/1000 or 15.00% and septic surgical department with 62.99 DDD/1000 or 11.20% on the fifth position. In figure 2 the total beta-lactam antibacterials and penicillins consumption of parenteral forms in DDD/1000 during 2010-2014 is shown.

In figure 2, parenteral forms of beta-lactam antibacterials and penicillins consumption is presented. The highest decrease of consumption in the evaluated period recorded the septic surgical department from 105.2 to 10.41 DDD/1000 or by 10.11 times, followed by the reanimation department from 356.14 to 181.09 DDD/1000 or by 49.15%, thirdly septic orthotraumatology department from 30.65 to 19.08 DDD/1000 or by 37.75% and on the last position – therapy intensive care department from 118.07 in 2010 to 97.11 DDD/1000 or by 17.75%. Only intensive neurological «stroke» department, from its establishment in the end of 2012, increased consumption from 86.96 in 2013 to 123.54 DDD/1000 in 2014 or by 42.07%.

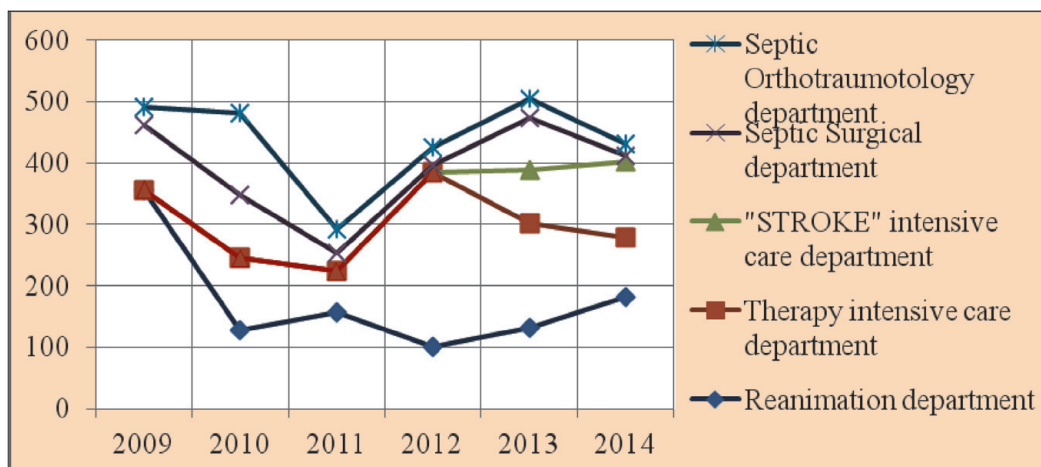


Fig. 2. Total beta-lactam antibacterials and penicillins consumption in DDD/1000 (parenteral forms).

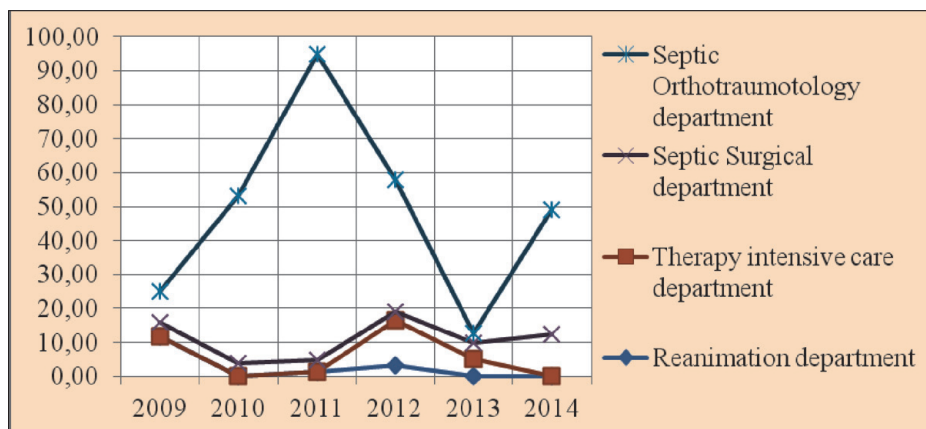


Fig. 3. Total beta-lactam antibacterials and penicillins consumption in DDD/1000 (enteral forms).

During 2009 to 2014 total departmental consumption of beta-lactam antibacterials and penicillins parenteral forms recorded a decrease from 491.99 to 431.23 DDD/1000 or by 12.35%. In figure 3 totals DDD/1000 of beta-lactam antibacterials and penicillins consumption during 2009-2014 are shown.

The data from figure 3, shows that in the evaluated period enteral forms of beta-lactam antibacterials and penicillins recorded an increment from 9.13 to 36.81 DDD/1000 or by 4.03 times in septic orthotraumatology department, from 3.99 to 12.31 DDD/1000 or by 3.08 times in septic surgical department. Other departments are characterized by an occasional consumption of this group of antibiotics. Totally during 2009 – 2014 years all departments recorded an increment from 24.90 to 49.12 DDD/1000 or by 97.27%.

Taking into consideration that in most scientific journals, published data about drugs consumption include the use of them in all intense care hospital unites; we determined the medium consumption of DDD/1000 separately for ICD and SSOTD of EMI. To determine this medium we summed the total of DDD/1000 separately for ICD and SSOTD and divided by the number of those departments (3 and respectively 2). The results are shown in table 1.

The data in table 1 shows that in the evaluated period total departmental consumption of parenteral forms was (356.14+67.93) =424.07 DDD/1000 in 2009 and respectively (133.91+14.75) =144.66 DDD/1000 in 2014, from which ICD represents respectively 83.98% and 90.08%, as well as SSOTD 16.08% and 9.92%. Total institutional use of parenteral forms recorded a significant decrease from 79.9 to 3.9 DDD/1000 or by 20.49 times and vice versa enteral forms an abrupt increase from 5.6 to 16.9 DDD/1000 or by 3.02 times.

The median registered consumption from the evaluation period of beta-lactam antibacterials and penicillins in ICD of EMI recorded 178.3 DDD/1000 or less by 2.52 to 3.93 times comparatively to 450 to 700 DDD/1000 registered in many ICD of international hospitals [5, 6, 19, 20].

In table 2 a comparison data on beta-lactam antibacterials and penicillins consumption in EMI and some international hospitals is shown.

From table 2, it could be observed that during the evaluated period consumption of beta-lactam antibacterials and penicillins in EMI recorded a spontaneous decrease from 85.5 to 20.8 DDD/1000 or by 4.11 times. Calculated beta-lactam antibacterials and penicillins medium annual

Table1

Beta-lactam antibacterials and penicillins consumption in (parenteral and enteral forms) in DDD/100

Department	Administration /Period of evaluation	2009	2010	2011	2012	2013	2014
ICD	Parenteral	356.14	122.54	111.76	192.17	129.79	133.91
	Enteral	11.78		0.644	8.337	2.64	
	Total	367.92	122.54	112.40	200.51	132.43	133.91
SSOTD	Parenteral	67.93	118.36	34.58	20.35	57.27	14.75
	Enteral	6.56	26.53	46.79	20.68	3.735	24.56
	Total	74.48	144.89	81.37	41.03	61	39.31
Total EMI	Parenteral	79.9	80	86.7	68.7	6.9	3.9
	Enteral	5.6	6.7	8.1	8.1	21.2	16.9
	Total	85.5	86.7	94.8	76.6	28.1	20.8

Table 2

Total DDD/1000 consumption of beta-lactam antibacterials and penicillins in EMI and same international hospitals

Institution/data/years	2009	2010	2011	2012	2013	2014
Emergency Medicine Institute	85.5	86.7	94.8	76.6	28.1	20.8
Total	662.4	558.2	622.1	542.4	546.9	464.1
Percentage	12.9%	15.54%	15.24%	14.12%	4.35%	4.48%
Large acute Australian public hospitals[5]	360.4	261.9	276.2	265.0	425.9	411.5
Total	931.8	933.7	946.5	931.6	943.4	922.6
Percentage	38.65%	28.05%	29.18%	28.45%	45.15%	44.6%
Programs/data/years	2012		2012 – 2013			
NAUSP; SAAUSP [6]			401.7; 425.8			
DANMAP; SWEDRES; NETHMAP	454; 302				313	
Total	931; 609		945; 943		712	
Percentage	48.77%; 49.59%		42.51%; 45.15%		43.96%	

expenditure of 65.42 DDD/1000 $[(85.5+86.7+94.8+76.6+28.1+20.8):6]$ represents 11.56% from 562.51 DDD/1000 $[(662.4+558.2+622.1+542.4+546.9+464.1):6]$ annual median of 6-year institutional antibiotics consumption. 6 years in large acute international public hospitals and data from other surveillance international programs show an increase of beta-lactam antibacterials and penicillins use from 360.4 to 411.5 DDD/1000 or by 14.18%, of which median share constituted 354.3 DDD/1000 $[(360.4+261.9+276.2+265.0+425.9+411.5+401.7+425.8+454+302+313) :11]$ or 40% from the total consumption of 886.26 DDD/1000 $[(931.8+933.7+946.5+931.6+943.4+922.6+931+609+945+943+712) :11]$, [5, 6]. From above mentioned analyses we can state that median annual consumption of beta-lactam antibacterials and penicillins in EMI recorded 5.42 (354.3: 65.42) times less than in majority of international hospitals. Nevertheless, consumption data can be found not corresponding to the median of all international hospitals, as an example is a Single University Hospital in Korea, where consumption of beta-lactam antibacterials and penicillins recorded 75 DDD/1000 in 2012 [18], which is more appropriate to the data registered in EMI.

The value cost of beta-lactam antibacterials and penicillins use per DDD/1000 in lei is presented in figure 4.

As could be stated from figure 4 during the evaluated period the main value cost per DDD/1000 from 6280,42 to 8041,7 lei or an increase by 28.04% recorded reanimation department, with the highest cost in 2011 of 23080.63 lei, consequently the second position by a decrease from 6227.42 lei in 2010 to 4985.7 lei per DDD/1000 or by 19.93% holds intensive therapy department, with the highest cost in 2011 of 19196 lei, the third position by an increase from 2598.50 lei in 2013 to 6620.4 lei per DDD/1000 or by 2.55 times holds intensive neurological «stroke» department followed by septic surgical department by the results from 1136.8 lei to 1428.04 lei per DDD/1000 or an increase by 25.62% with the highest cost in 2013 of 2494.45 lei per DDD/1000 and the fifth position – septic orthotraumatology department with the cost of from 622.38 to 711.19 lei and the highest cost in 2011 of 2369.68 lei per DDD/1000.

In figure 5 the total value cost of beta-lactam antibacterials and penicillins in DDD/1000 (parenteral forms) is presented.

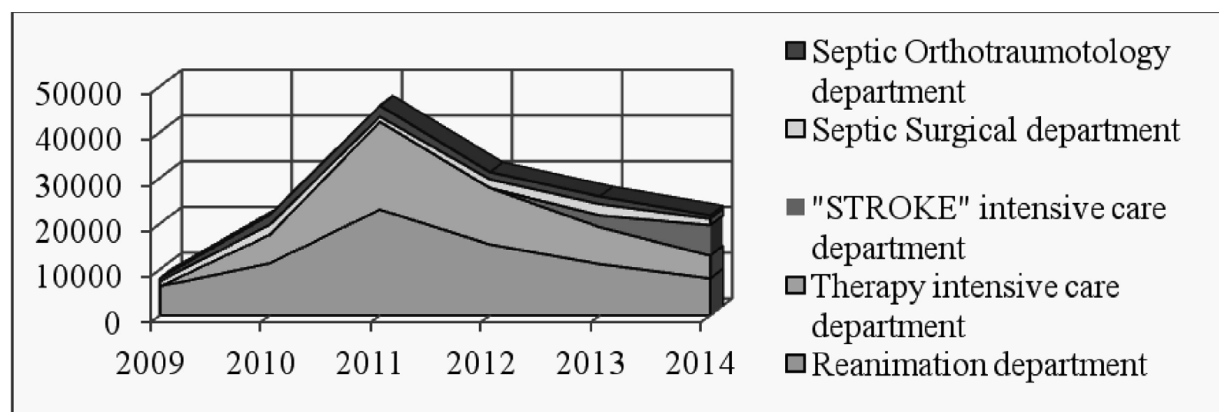


Fig. 4. Total value cost of beta-lactam antibacterials and penicillins per DDD/1000 in lei.

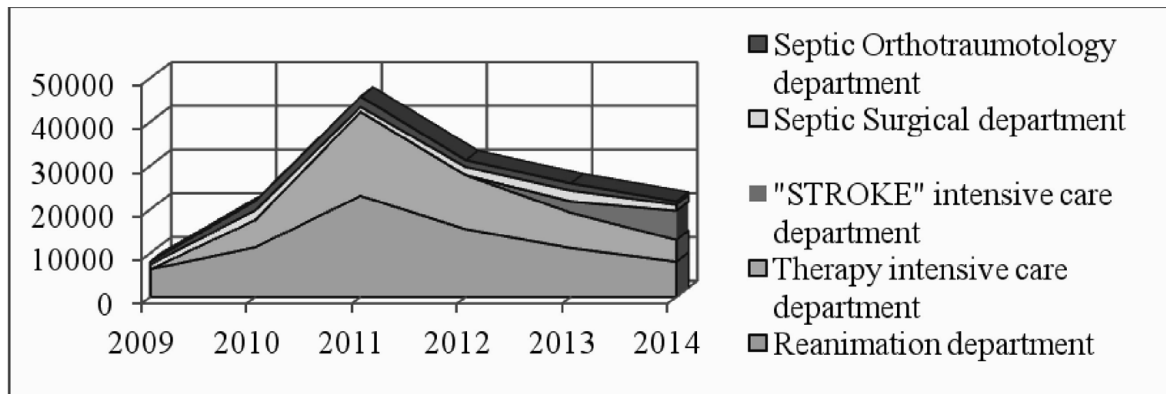


Fig. 5. Value cost of beta-lactam antibacterials and penicillins in DDD/1000 of parenteral forms in lei.

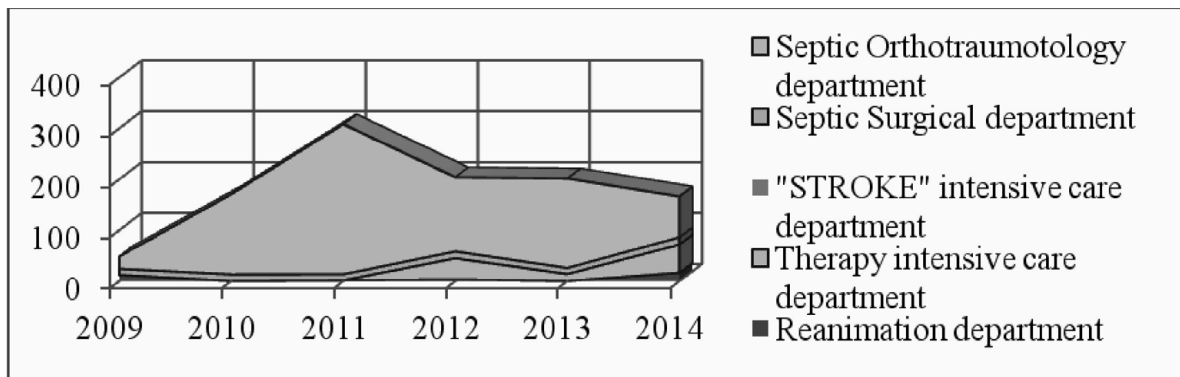


Fig. 6. Value cost of beta-lactam antibacterials and penicillins in DDD/1000 (enteral forms) in lei.

The cost of parenteral beta-lactam antibacterials and penicillins in DDD/1000 for all departments remains approximately the same in comparison with the total consumption because of low cost of enteral forms for DDD/1000. In figure 6 the value cost in DDD/1000 in lei of beta-lactam antibacterials and penicillins enteral forms is shown.

Presented data in chart 6, demonstrates that from the total departments annual cost could be placed as follows: the first – septic orthotraumatology department with the

value cost from 23.89 to 80.12 lei per DDD/1000, with the higher value of 294.48 lei in 2011, the second – therapy intensive care department with an increment from 41.64 to 55.38 lei, the third – septic surgical department with the value cost from 12.34 to 14.34 lei per DDD/1000.

To determine the medium cost of DDD/1000 was counted the total cost of DDD/1000 separately for ICD and SSOTD and divided by the number of those departments (3 and respectively 2) in the evaluated period.

Table 3

Medium cost of DDD/1000 in lei of beta-lactam antibacterials and penicillins (parenteral and enteral forms) in IC and SSOT departments of EMI

Department	Structure of consumption	2009	2010	2011	2012	2013	2014
ICD	Parenteral	6246.62	8778.86	21136.10	13866.25	7260.20	6549.27
	Enteral	33.80		11.78	22.37	6.87	41.02
	Total	6280.42	8778.86	21147.88	13888.62	7264.07	6549.28
SSOTD	Parenteral	861.46	2080.30	1599.00	1652.75	1970.80	1022.38
	Enteral	18.11	85.16	153.25	79.48	93.76	47.23
	Total	879.57	2165.46	1752.25	1732.23	2064.56	1069.62
Total EMI	Parenteral	687.84	2324.48	2316.66	2445.57	1504.38	544.14
	Enteral	14.76	18.73	23.82	22.79	38.39	25.70
	Total	702.6	2343.21	2340.48	2468.36	1542.77	569.84

As could be seen from table 3 in the evaluated period total medium cost of DDD/1000 for beta-lactam antibacterials and penicillins recorded an increase in ICD from 6280.42 to 6549.28 lei or by 4.78%, with the higher cost of 21147.88 lei in 2011. Consequently, in SSOTD from 879.57 to 1069.62 lei or by 21.61%, with the higher cost of 2165.46 lei in 2010, as well as for the entire institution a decrease from 702.6 to 569.84 lei or by 18.90% and the higher cost of 2468.36 lei in 2012. The share of value cost per DDD/1000 in 2014 constituted less by 6.12 times for SSOTD and by 11.49 times for EMI from value cost of 6549.28 lei for DDD/1000 recorded in ICD.

Conclusions

1. In EMI during the evaluated period the use of beta-lactam antibacterials and penicillins recorded a decrease from 85.5 to 20.8 DDD/1000 or by 75.67% and vice versa an increment from 360.4 to 411.5 DDD/1000 or by 14.18% in international hospitals was registered. Medium annual consumption within the evaluated period in EMI recorded 5.42 (354.3: 65.42) times less than in majority of international hospitals.

2. As to the annual medium consumption of 562.51 DDD/1000 all departments could be placed as follows: the first – reanimation department with 178.08 DDD/1000 or 31.66%, the second – intensive therapy care department with 131.82 DDD/1000 or 23.43%, the third – intensive neurological «stroke» department with 105.25 DDD/1000 or 18.71%, the fourth – septic orthotraumatology department with 84.37 DDD/1000 or 15.00% and septic surgical department with 62.99 DDD/1000 or 11.20% on the fifth position.

3. Consumption in ICD departments of EMI in the considered period recorded a decrease from 367.92 to 133.91 DDD/1000 or by 63.60% and counted a medium of 178.79, while in ICU of international hospitals the medium consumption constitutes 575 DDD/1000 or by 3.22 times more.

4. Total institutional parenteral forms recorded a significant decrease from 79.9 to 3.9 DDD/1000 or by 20.49 times and vice versa enteral forms a spontaneous increase from 5.6 to 16.9 DDD/1000 or by 3.02 times.

5. Total medium cost per DDD/1000 of beta-lactam antibacterials and penicillins recorded an increase in ICD from 6280.42 to 6549.28 lei or by 4.78% and consequently in SSOTD from 879.57 to 1069.62 or by 21.61%, as well as per entire institution a decrease from 702.6 to 569.84 lei or by 18.90%.

6. Obtained data about consumption dynamics of beta-lactam antibacterials and penicillins in EMI and their main departments in comparison with international hospitals represents important arguments and reserves for improving quality of treatment, planning and rational use of antibiotics in hospitals.

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