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BAPCOC
Belgian Antibiotic Policy Coordination Committee

SYSTEMIC ANTIMICROBIAL DRUG USE IN BELGIAN HOSPITALS

2006 – 2007

Epidemiology

Juliette Wytsmanstraat 14
1050 Brussel | Belgium

www.iph.fgov.be

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S. Vaerenberg, E. Hendrickx, B. Catry

Section Epidemiology

Juliette Wytsmanstraat 14, 1050 Brussels

T 02 642 57 01 | F 02 642 54 10

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Acknowledgments

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Abbreviations

AMD	antimicrobial drug
ATC	Anatomical Therapeutical Chemical Classification
BAPCOC	Belgian Antibiotic Policy Coordination Committee
DDA	Daily Dose of Administration
DDD	Defined Daily Dose
HAO	hematology-oncology wards
ICU	intensive care units
IPH	Scientific Institute of Public Health
N	number
NPD	non-pediatric wards
PED	pediatric wards
TOT	total of all wards
TUC	Tarification Unit Code
WHO	World Health Organization
IV	intravenous

1 Introduction

Antimicrobial resistance not only leads to increased morbidity and mortality, but also to increased expenses in medication and health care. The European Council of Ministers therefore recommended enhancing the prudent use of antimicrobial drugs (AMD) via national policies and action plans (1).

In 2002 Belgium started financing multidisciplinary antibiotic policy groups in a limited number of hospitals (2). This group of hospitals was gradually enlarged, and today all acute and long term care hospitals with more than 150 beds receive funds for an antibiotic policy deputy (3)(4). The tasks of the antibiotic policy groups are defined by royal decree (5), and their activities are monitored by the Belgian Antibiotic Policy Coordination Committee (BAPCOC) (6). To enable close follow up of antimicrobial drug use, hospitals are obliged to report their antimicrobial use to BAPCOC through the Scientific Institute of Public Health (IPH) which is responsible for the data collection and analysis.

2 Objectives

The first objective was to provide a standardized tool for the hospitals that allows them to have a better view on their own AMD use and it's evolution. In addition, the tool will enable the hospitals to compare their own AMD use with the national mean (benchmarking). A further objective was to monitor systemic antimicrobial drug use in Belgian acute care hospitals and long term care facilities with more than 150 beds.

3 Material and methods

3.1 Data collection

For 2006, all data were sent by email. This method was not considered feasible for large numbers of participating hospitals due to the vast amount of work to recode and clean the data. Therefore, it was decided that a web-based data upload module would be created. This website has been used to collect the data since 2007.

3.1.1 Website

A password protected web-based module was created (Figure 1) by the IPH to collect nominator (AMD use) as well as denominator data (bed-days, admissions).

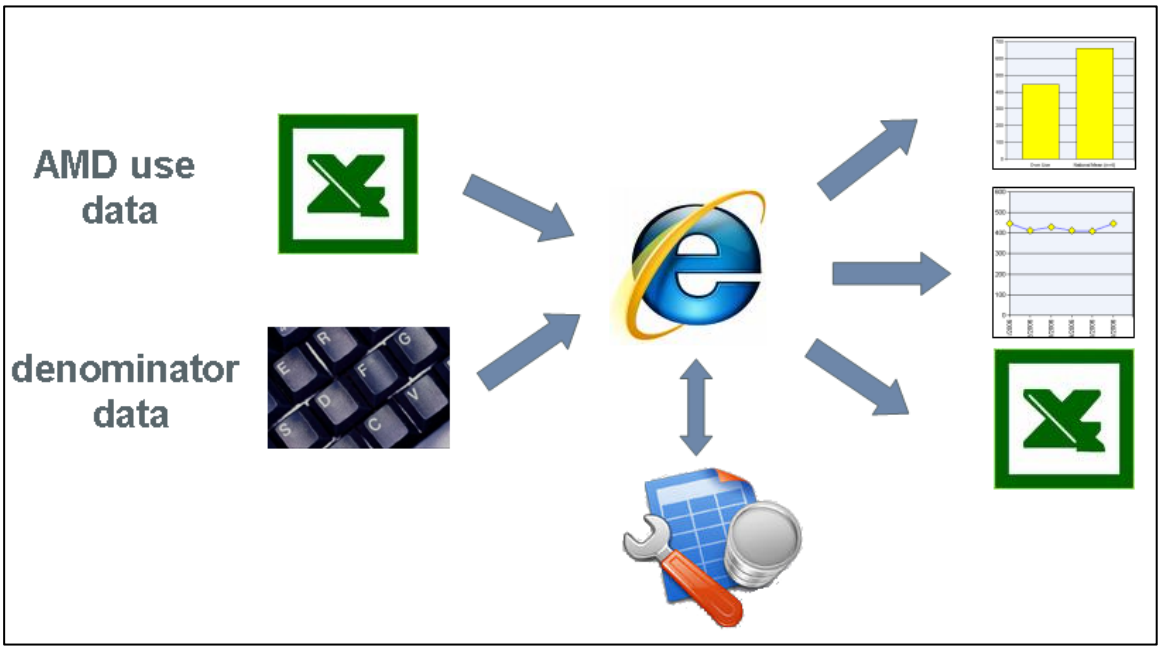

Figure 1 - Concept of the website

The web module calculates the Defined Daily Dose (DDD) per 1000 bed-days for each ATC code (Anatomical Therapeutical Chemical Classification) according to WHO guidelines[1]. After introducing the consumption and denominator data, several analyses can immediately be performed on-line by the hospitals themselves.

[1] WHO guidelines for ATC classification and DDD assignment, 2009 version (7)

3.2 Data

3.2.1 Wards

All wards except psychiatric wards were included in the surveillance[2] (TOT).
Subdivisions were made as follows:

- non-pediatric wards (NPD)
- pediatric wards (PED)
- intensive care unit (ICU) (optional)
- hematology-oncology unit (HAO) (optional)

3.2.2 Nominator data

A list of AMD specialties available in Belgium and identified by their TUC was published on the website for the participating hospitals. This list defines all AMD specialties of which use had to be reported and is annually updated by the IPH.
The ATC classes represented in the list were:

- J01 Antibacterials for systemic use
- J02 Antimycotics for systemic use
- J04A Drugs for treatment of tuberculosis
- A07A Intestinal anti-infectives
- P01AB Agents against amoebiasis and other protozoal diseases
- D01B Antifungals for systemic use

Hospitals uploaded their AMD use data as numbers of Tarification Unit Codes (TUC)[3].
The use in TUC was subsequently converted to the use in DDD and DDA[4] (Daily Dose of Administration). This made comparisons between hospitals and over years possible.

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2 More details on the specification of the wards can be found in the surveillance protocol : http://www.nsih.be/surv_gm/download_nl.asp or http://www.nsih.be/surv_gm/download_fr.asp

3 These codes are normally used for reimbursement purposes. Definitions of the National Institute of Sickness and Invalidity Insurance (RIZIV/INAMI) were used (8).

4 DDA : Defined Dose of Administration. A daily dose defined by the BAPCOC working group for hospital care according to the routine use of specific specialties in current Belgian practice, as a proxy for adult and pediatric daily doses.

3.2.3 Denominator data

The denominators asked were:

- bed-days
- admissions
- admissions with antimicrobial treatment (optional)

3.3 Data Analysis

All data were analyzed using statistical software Stata 10. In section 4.6 (Results by hospital unit) and 4.7 (Results of stratified analyses) pediatric wards were not represented separately because DDD and DDA are not suited as a definite measure for AMD use in pediatrics.

4 Results

4.1 Participation

In 2006, a total of 28 hospitals participated on a voluntary basis (test phase). Five of these hospitals submitted monthly data. In 2007, 55 hospitals participated of whom 14 provided monthly data. There were 23 hospitals participating both in 2006 and 2007 (Table 1).

Table 1 - Number of participating hospitals

	2006	2007	2006 & 2007
Type of data			
Annual	23	41	18
Monthly	5	14	5
Total	28	55	23

Although optional, 75% of participating hospitals reported on the use in ICU, 39% reported on the use in HAO in 2006. For 2007, 82% and 36% reported on ICU and HAO respectively (Table 2).

Table 2 - Number of participating hospitals, by ward

	2006	2007	2006 & 2007
Hospital unit			
TOT	28	55	23
PED	26	47	21
NPD	26	55	21
ICU	21	45	18
HAO	11	20	9

4.2 Data quality

Overall, the data quality for 2007 was better than for 2006, thanks to the standardized format. Descriptive statistics allowed us to identify some hospitals as severe outliers. These were contacted and asked to review their data. Some of them indeed found a mistake in their data and submitted corrected data.

4.3 Overall Antimicrobial Drug Use

4.3.1 All participating hospitals

4.3.1.1 All antimicrobials (J01 + J02 + J04A + A07A + P01AB + D01B)

The median overall AMD use was 479 DDD/1000 bed-days for 2006 and 556 DDD/1000 bed-days for 2007. The dispersion of the AMD use was larger for 2007 than for 2006, which can be explained by the larger number of participating hospitals in 2007 (Figure 2).

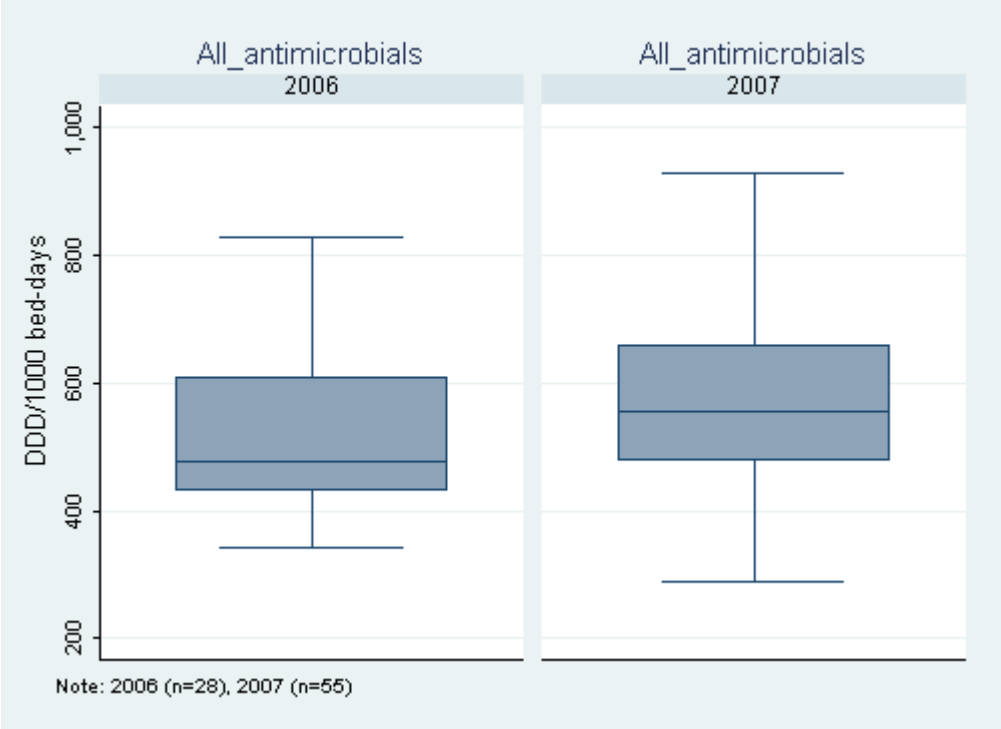


Figure 2 - Total AMD use (DDD/1000 bed-days), 2006 and 2007

The DDD/1000 admissions showed more variation (Figure 3). This can be explained by the high mean length of stay of some hospitals.

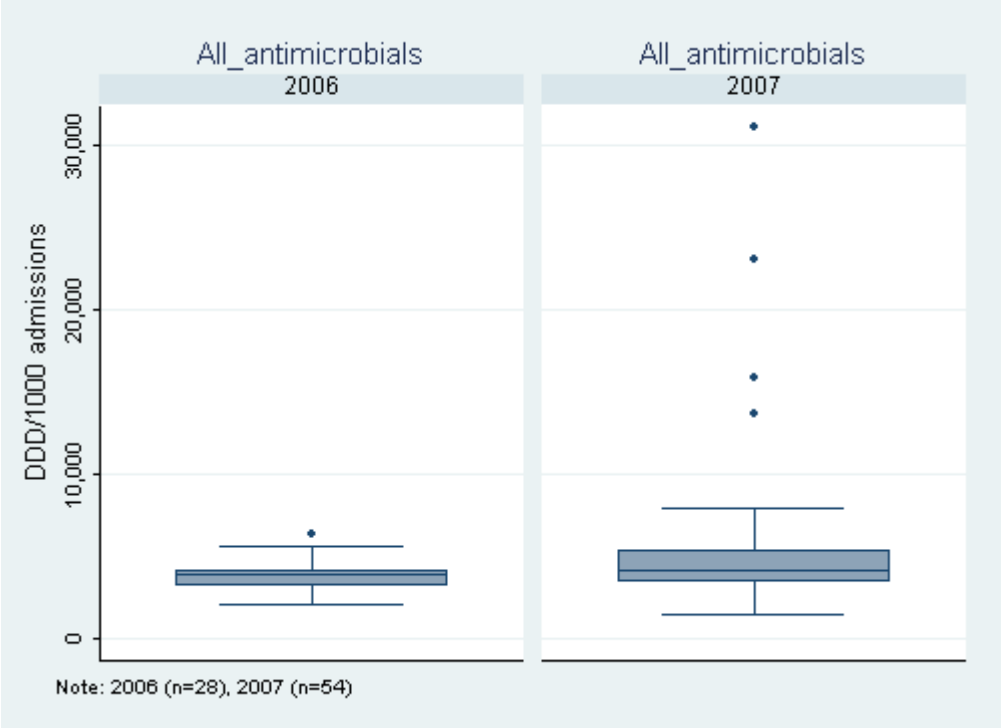


Figure 3 - Total AMD use in (DDD/1000 admissions), 2006 and 2007

4.3.1.2 Antibacterials for systemic use (J01)

The median overall use of antibacterials was 457 DDD/1000 bed-days for 2006 and 520 DDD/1000 bed-days for 2007. The dispersion of the antibacterial use was larger for 2007 than for 2006, which can be explained by the greater number of participating hospitals in 2007 (Figure 4).

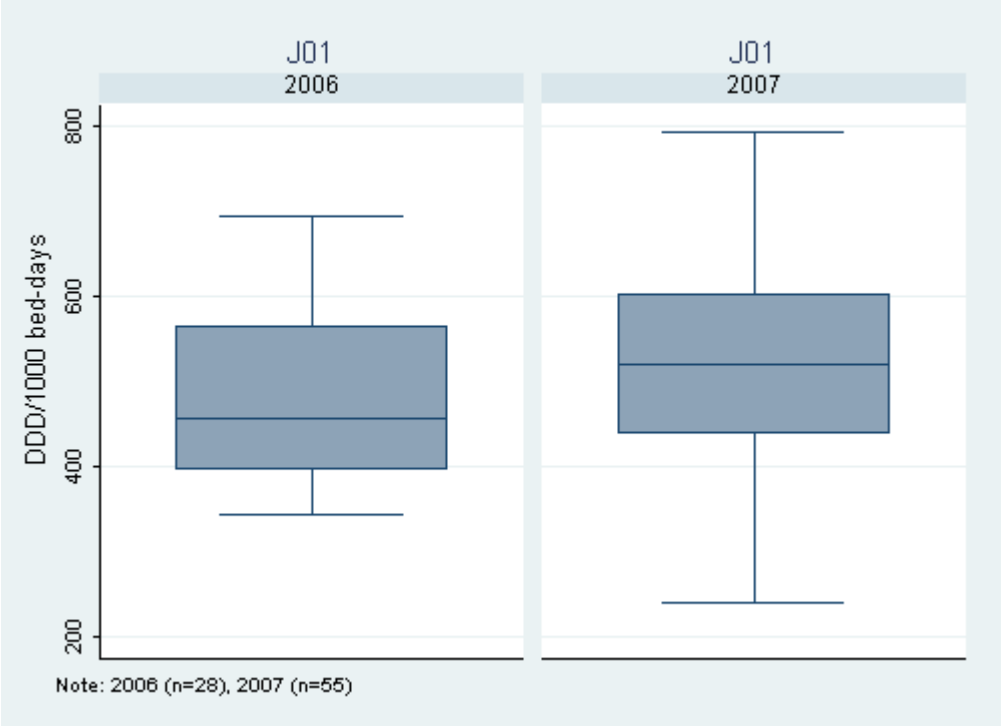


Figure 4 - Use of antibacterials (DDD/1000 bed-days), 2006 and 2007

The DDD/1000 admissions showed more variation (Figure 5). This can be explained by the high mean length of stay of some hospitals.

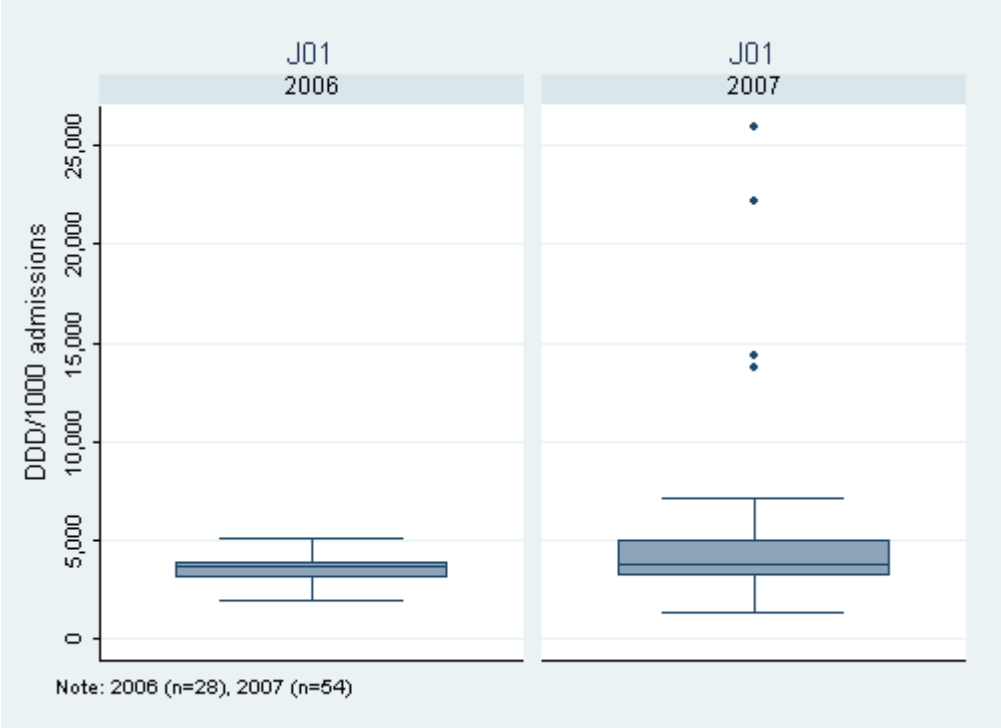


Figure 5 - Use of antibacterials in (DDD/1000 admissions), 2006 and 2007

4.3.1.3 Antimycotics for systemic use (J02)

The median overall use of antimycotics was 17 DDD/1000 bed-days for 2006 and 22 DDD/1000 bed-days for 2007. The dispersion of the antimycotic use was larger for 2007 than for 2006, which can be explained by the greater number of participating hospitals in 2007 (Figure 6).

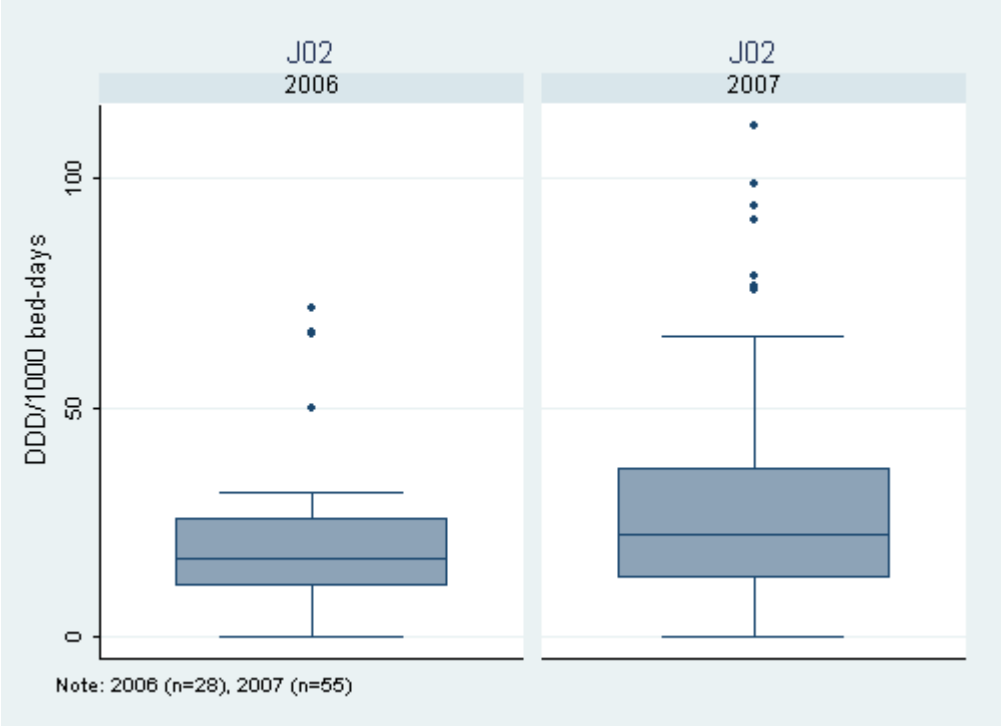


Figure 6 - Use of antimycotics (DDD/1000 bed-days), 2006 and 2007

The DDD/1000 admissions showed more variation (Figure 7). As outlined before, this can be explained by the high mean length of stay of some hospitals.

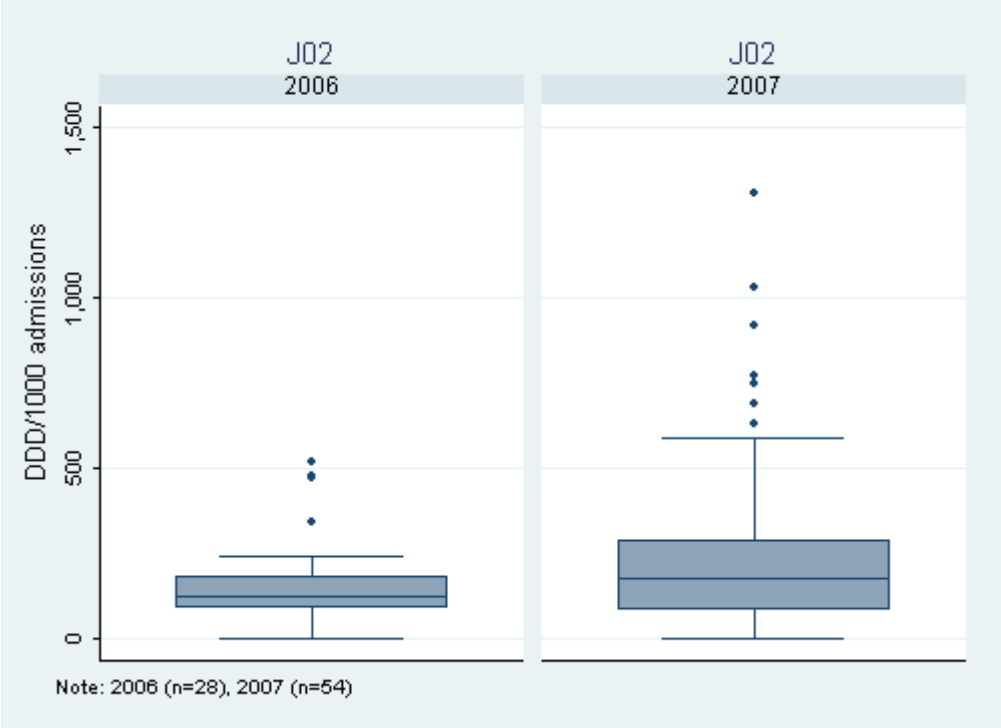


Figure 7 - Use of antimycotics (DDD/1000 admissions), 2006 and 2007

4.3.1.4 Tuberculostatics (J04A)

The median overall use of tuberculostatics was 7 DDD/1000 bed-days for 2006 and 6 DDD/1000 bed-days for 2007 (Figure 8).

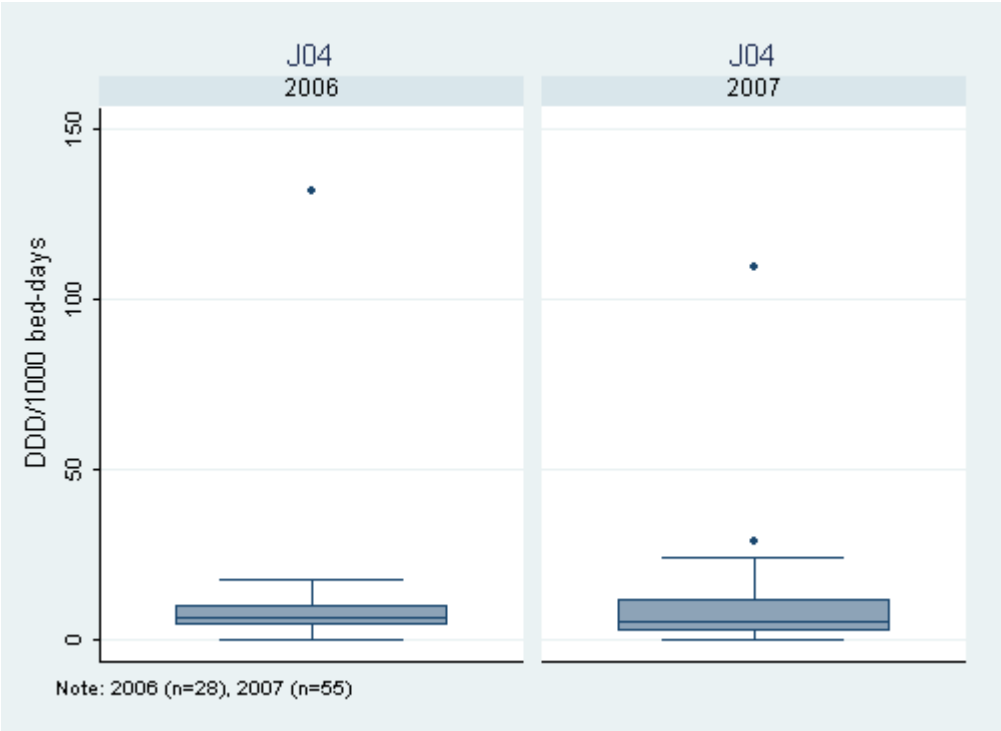


Figure 8 - Use of tuberculostatics (DDD/1000 bed-days), 2006 and 2007

Expressed as DDD/1000 admissions, the median overall use of tuberculostatics was 45 DDD/1000 admissions for 2006 and 54 DDD/1000 admissions for 2007. In 2007, two severe outliers were seen (Figure 9).

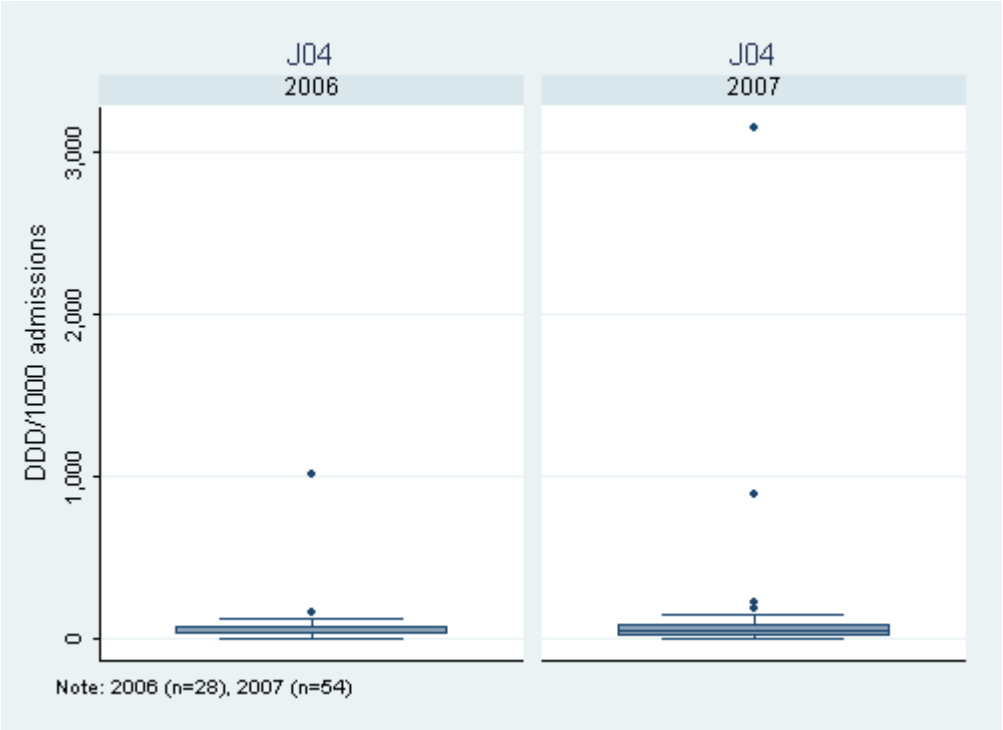


Figure 9 - Use of tuberculostatics (DDD/1000 admissions), 2006 and 2007

4.3.2 Hospitals participating both in 2006 and 2007

4.3.2.1 All antimicrobials (J01 + J02 + J04A + A07A + P01AB + D01B)

Twenty-three hospitals participated both in 2006 and 2007. For these hospitals we saw a small increase in the median DDD/1000 bed-days (525 for 2006, 549 for 2007) (Figure 10). When the AMD use was expressed as DDD/1000 admissions, there was no increase (3943 for 2006 versus 3944 for 2007) (Figure 11).

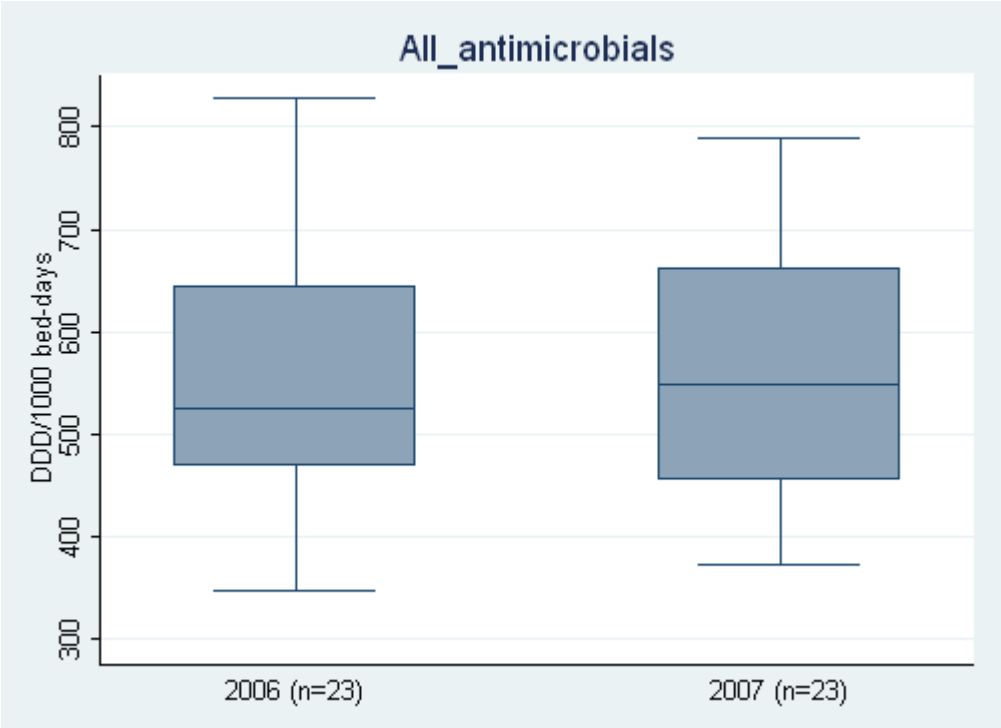


Figure 10 - Total AMD use (DDD/1000 bed-days) for hospitals participating both in 2006 and 2007

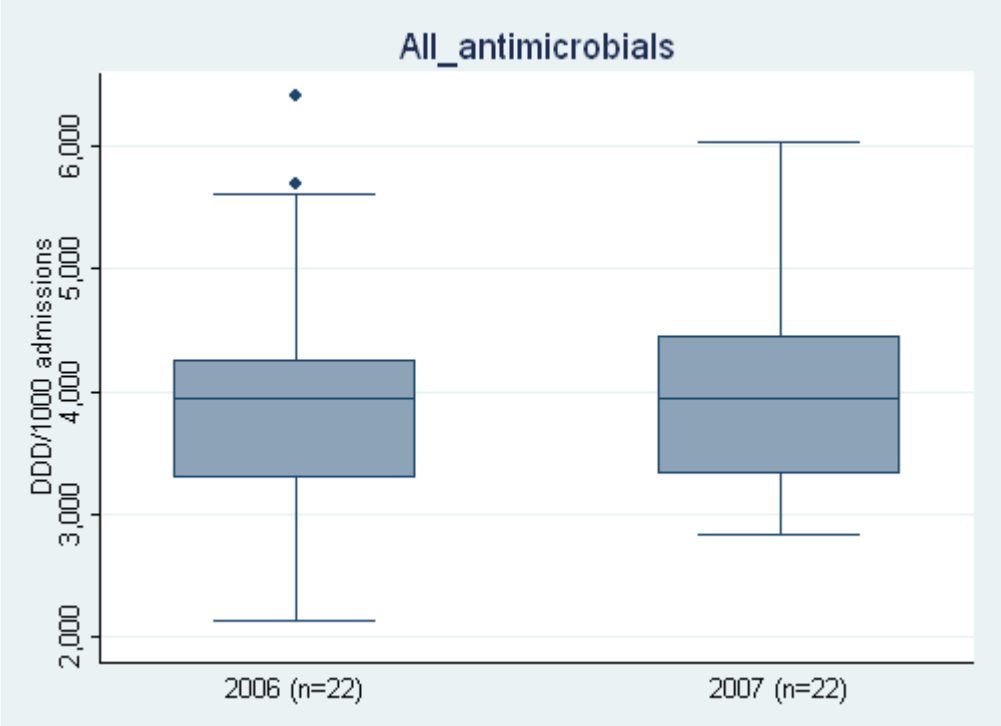


Figure 11 - Total AMD use (DDD/1000 admissions) for hospitals participating both in 2006 and 2007

4.3.2.2 Antibacterials for systemic use (J01)

For the hospitals that participated both in 2006 and 2007 a small increase was seen for the median DDD/1000 bed-days (484 for 2006, 517 for 2007) (Figure 12). When the antibacterial use was expressed as DDD/1000 admissions, the median did not increase (3668 for 2006 versus 3551 for 2007) (Figure 13).

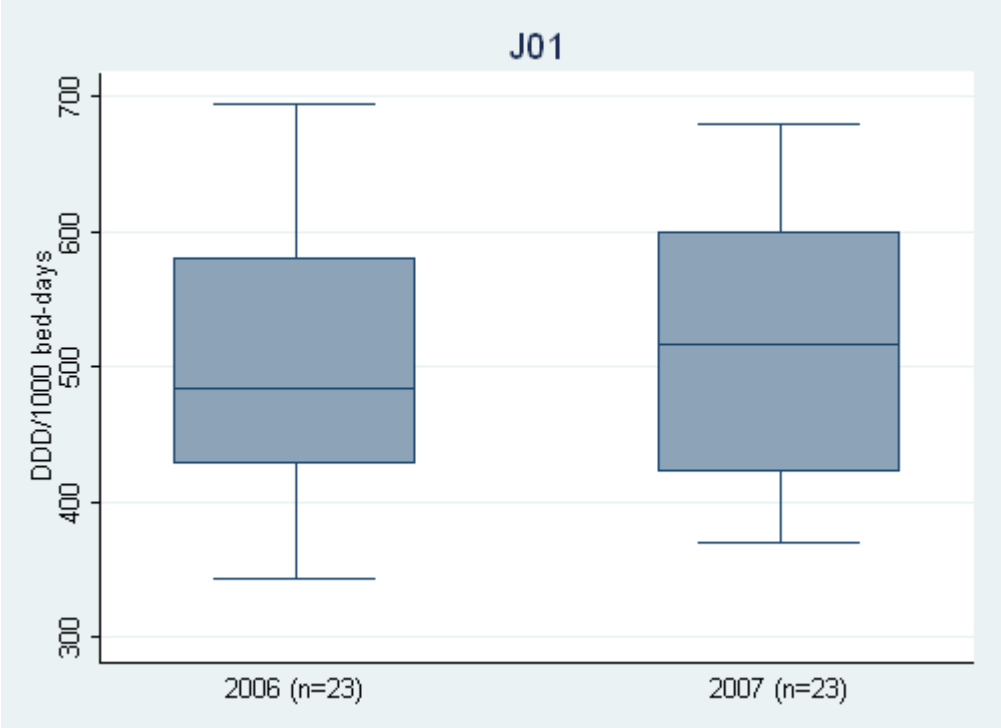


Figure 12 - Use of antibacterials (DDD/1000 bed-days) for hospitals participating both in 2006 and 2007

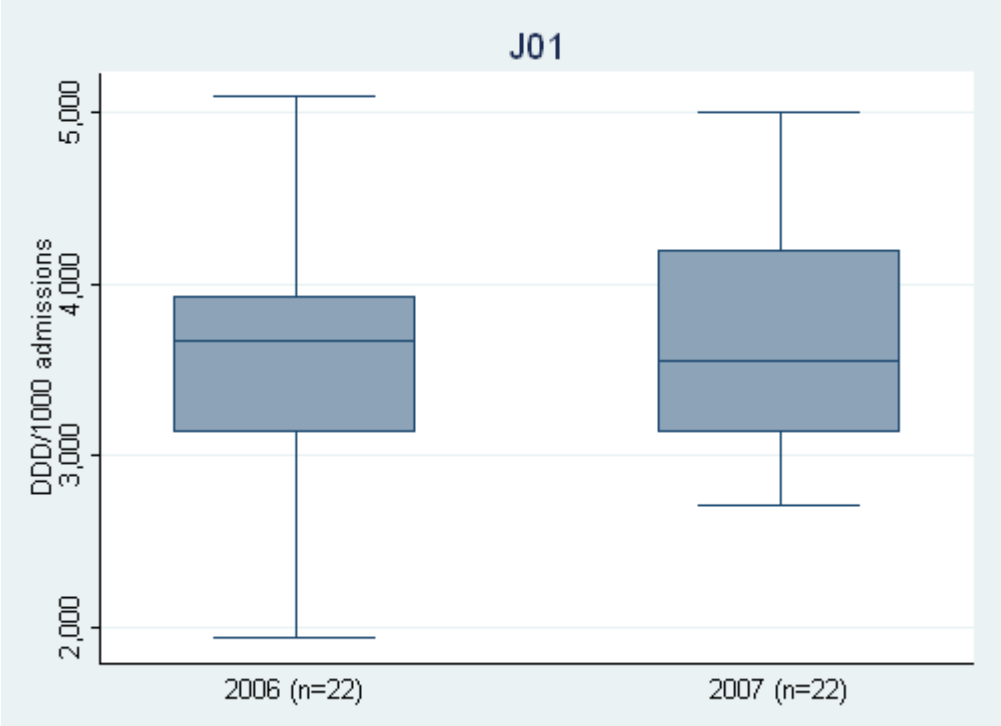


Figure 13 - Use of antibacterials (DDD/1000 admissions) for hospitals participating both in 2006 and 2007

4.3.2.3 Antimycotics for systemic use (J02)

For the hospitals that participated both in 2006 and 2007 the median antimycotic use (DDD/1000 bed-days) was comparable (21 for 2006, 22 for 2007) (Figure 14). When the antimycotic use was expressed as DDD/1000 admissions, there was a small increase (134 for 2006 versus 140 for 2007) (Figure 15).

Figure 14 - Use of antimycotics (DDD/1000 bed-days) for hospitals participating both in 2006 and 2007

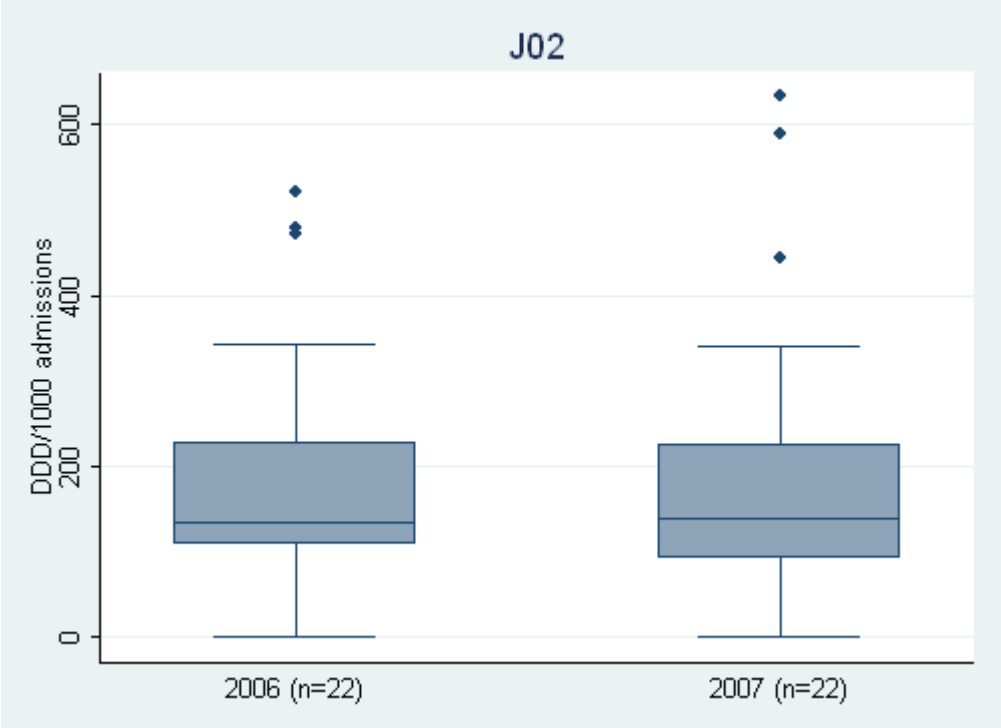


Figure 15 - Use of antimycotics (DDD/1000 admissions) for hospitals participating both in 2006 and 2007

4.3.2.4 Tuberculostatics (J04A)

For the hospitals that participated both in 2006 and 2007 the median use of tuberculostatics (DDD/1000 bed-days : 7.5 for 2006, 7.8 for 2007 and DDD/1000 admissions : 54.8 for 2006 versus 54.3 for 2007) were comparable (Figure 16, Figure 17).

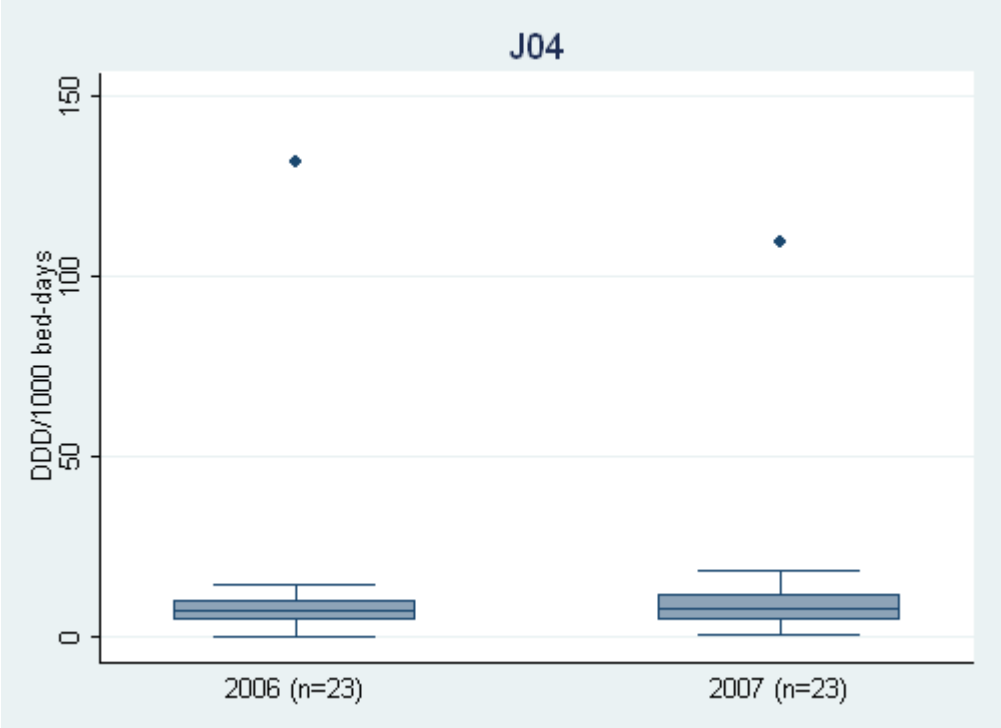


Figure 16 –Use of tuberculostatics (DDD/1000 bed-days) for hospitals participating both in 2006 and 2007

Figure 17 - Use of tuberculostatics (DDD/1000 admissions) for hospitals participating both in 2006 and 2007

4.3.3 Most used molecules

4.3.3.1 All participating hospitals

For both years, amoxicillin with enzyme inhibitor was by far the most used molecule. Most of the top 15 molecules were used more in 2007 compared to 2006. Only cefazolin, levofloxacin and ampicillin were used less in 2007 than in 2006. The use of vancomycin, cefuroxime and ceftazidime remained stable (Figure 18).

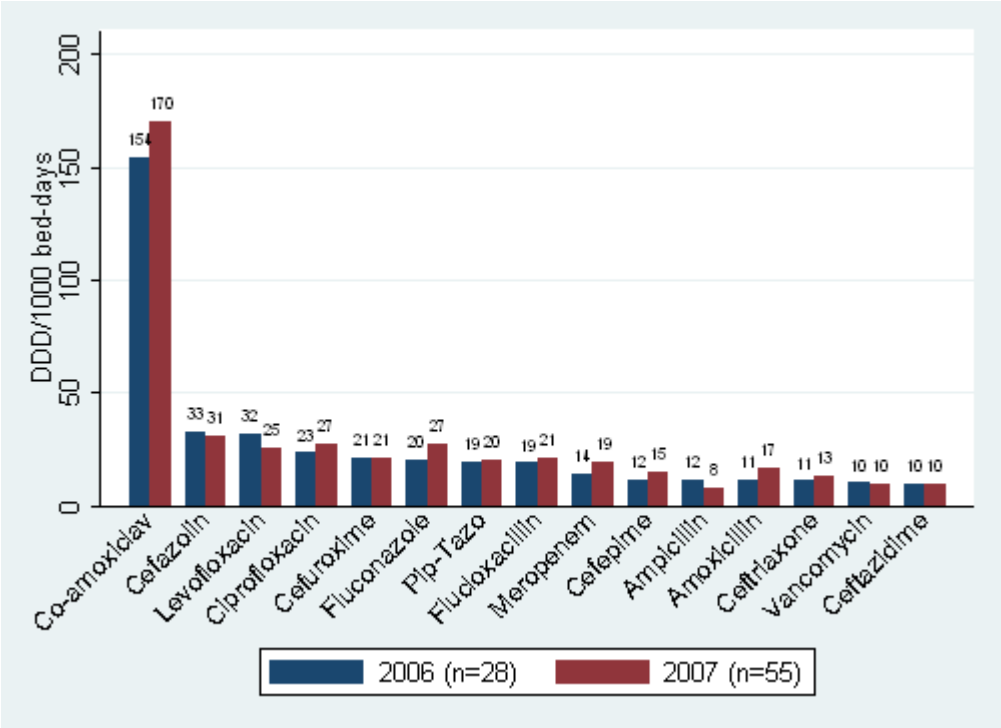


Figure 18 - Top 15 molecules, 2006 and 2007

4.3.3.2 Hospitals participating both in 2006 and 2007

There was an increase in the use of fluconazole, co-amoxiclav, amoxicillin, cefazolin, flucloxacillin, piperacillin-tazobactam, meropenem and ceftriaxone. Vancomycin and ciprofloxacin remained stable whereas the use of ampicillin, cefepime, cefuroxime, levofloxacin and ceftazidime decreased (Figure 19).

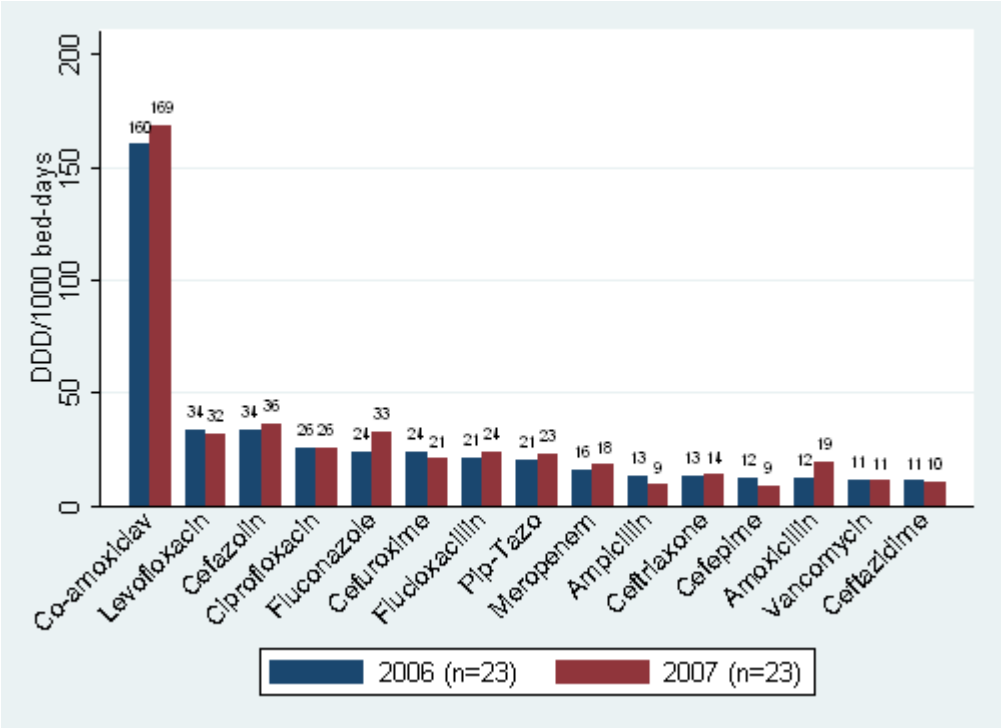


Figure 19 - Top 15 molecules, hospitals participating both in 2006 and 2007

4.4 AMD Use of different subgroups, all hospitals

4.4.1 ATC-2 level

Relative use

For 2006 and 2007, the distribution of the AMD use on ATC-2 level was almost identical. In 2007, 92 percent of the AMD use consisted of antibacterials for systemic use (J01). The second biggest group were the antimycotics for systemic use (J02). All other groups together (J04A, P01AB, A07A, D01B) accounted for only 3 percent (Figure 20).

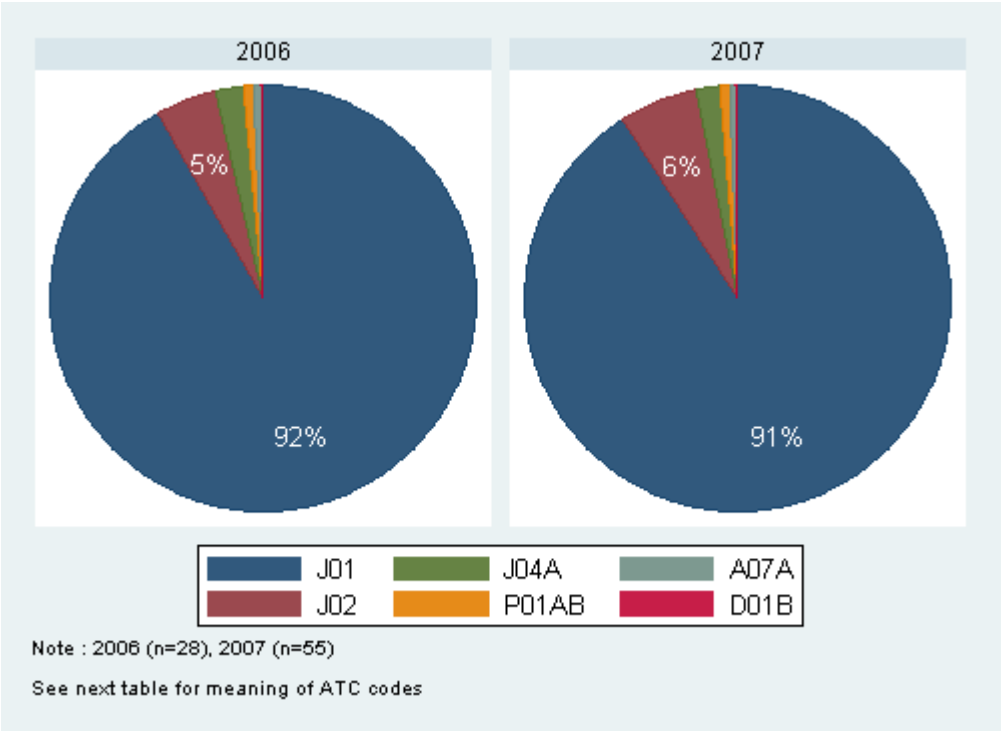


Figure 20 - Distribution of the total AMD use on ATC-2 level, 2006 and 2007

Mean use

Overall, there is a small increase in the mean AMD use. For 2006 and 2007 the mean use was 537 and 576 DDD/1000 bed-days, respectively (Table 3).

Table 3 - AMD use of subgroups on ATC-2 level (DDD/1000 bed-days), 2006 and 2007

		2006 (n=28)		2007 (n=55)	
Class	**ATC**	**Mean**	**Range**	**Mean**	**Range**
Antibacterials for systemic use	J01	492	344 - 694	524	242 - 792
Antimycotics for systemic use	J02	25	0 - 72	34	0 - 111
Antimycobacterials	J04A	12	0 - 132	11	0 - 110
Antiprotozoals	P01AB	4	0 - 7	4	0 - 10
Antidiarrheals, intestinal antiinflammatory/antiinfective agents	A07A	3	0 - 21	3	0 - 14
Antifungals for dermatological use	D01B	1	0 - 6	1	0 - 6
Total		537	344 - 827	576	290 - 929

4.4.2 ATC-3 and ATC-4 level

4.4.2.1 Antibacterials for systemic use (J01)

Relative use

For 2006 and 2007, the distribution of the AMD use between the different subgroups of the antibacterials for systemic use was the same. Almost half of all antibacterials for systemic use consisted of penicillins (J01C). The next biggest groups were the 'other beta-lactam antibacterials'[5] (J01D, 22%) and the quinolones (J01M, 13%) (Figure 21).

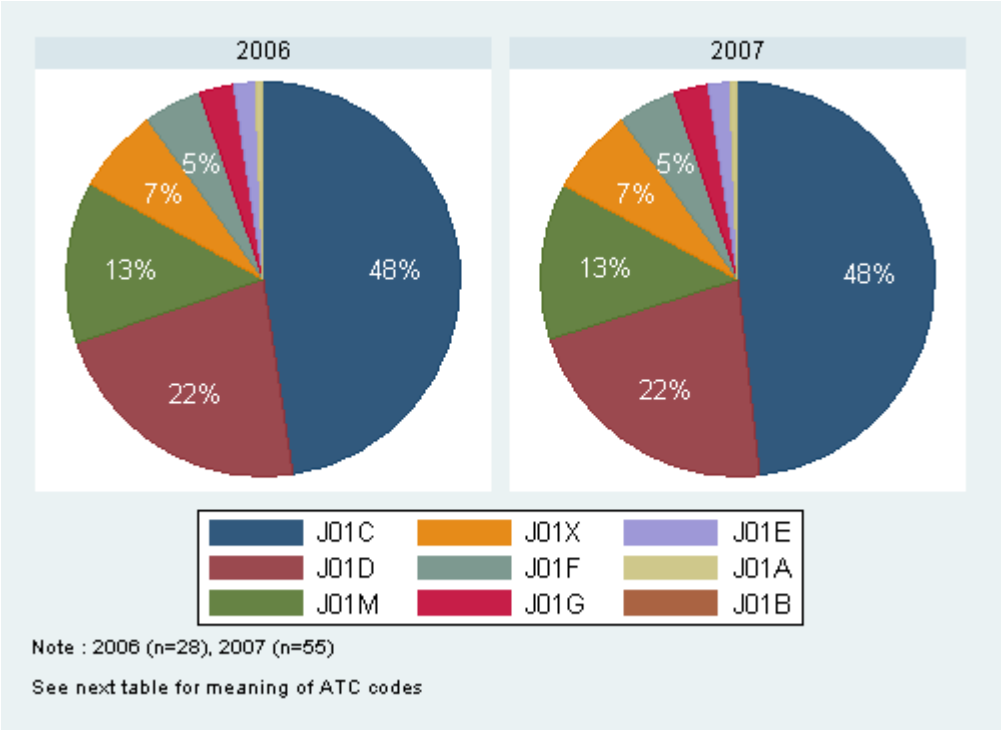


Figure 21 - Distribution of AMD use of the J01 class, 2006 and 2007

Mean use

Overall, there is a small increase in the mean use of antibacterials for systemic use. For 2006 and 2007 the mean use was 492 and 524 DDD/1000 bed-days, respectively (Table 4).

[5] other beta-lactam antibacterials : cephalosporins, monobactams and carbapenems

Table 4 - Use of the subgroups of ATC group J01 (DDD/1000 bed-days), 2006 and 2007

		2006 (n=28)		2007 (n=55)	
Class	**ATC**	**Mean**	**Range**	**Mean**	**Range**
Beta-lactam antibacterials, penicillins	J01C	234	168 - 375	253	100 - 380
Other beta-lactam antibacterials	J01D	109	39 - 175	114	17 - 244
Quinolone antibacterials	J01M	65	8 - 102	67	7 - 115
Other antibacterials	J01X	35	12 - 61	37	10 - 81
Macrolides, lincosamides and streptogramins	J01F	23	8 - 38	25	7 - 64
Aminoglycoside antibacterials	J01G	14	1 - 38	14	1 - 55
Sulfonamides and trimethoprim	J01E	8	1 - 22	9	1 - 29
Tetracyclines	J01A	3	0 - 13	3	0 - 44
Amphenicols	J01B	0	0 - 1	0	0 - 3
Total		492	344 - 694	524	242 - 792

4.4.2.2 Penicillins (J01C)

Relative use

For 2006 and 2007, the distribution within the penicillin group (J01C) use was almost identical. The combinations of a penicillin with a beta-lactamase inhibitor (J01CR) counted for 75% of all penicillin use. The next biggest groups were the penicillins with extended spectrum (J01CA, 12%) and the beta-lactamase resistant penicillins (J01CF, 11%) (Figure 22). The use of beta-lactamase sensitive penicillins (J01CE) was very low.

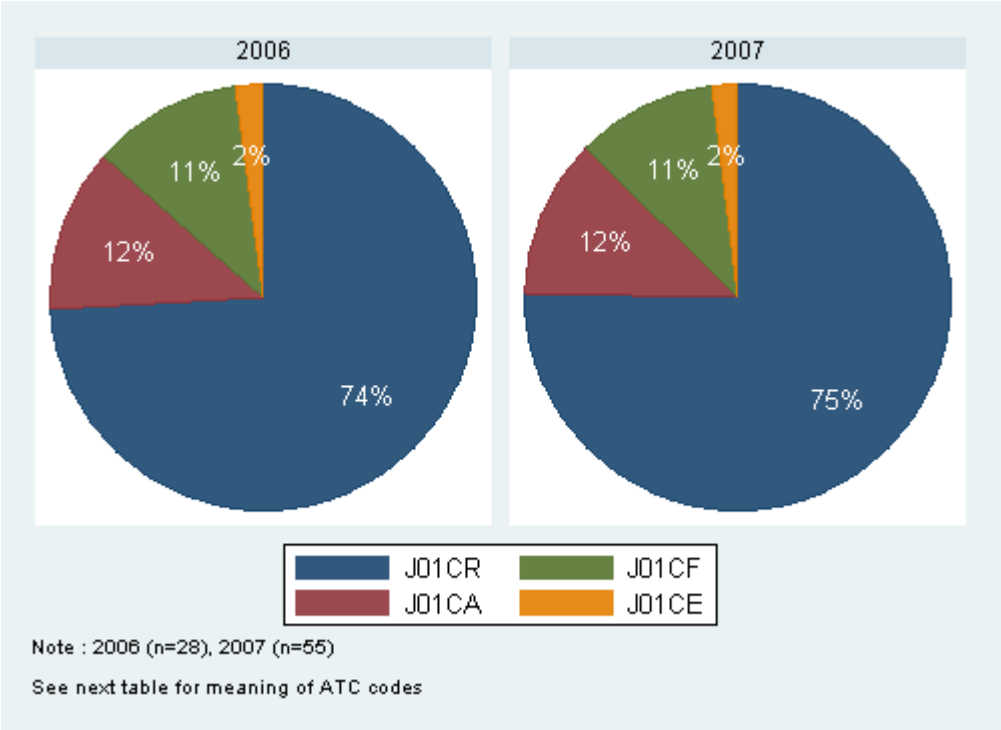


Figure 22 - Distribution of AMD use in the J01C class

Mean use

The mean use of penicillins for systemic use was 234 and 253 DDD/1000 bed-days for 2006 and 2007, respectively. The mean use of penicillins with beta-lactamase inhibitor was higher in 2007 (191 DDD/1000 bed-days) than in 2006 (174 DDD/1000 bed-days) (Table 5).

Table 5 - Use of the subgroups of ATC group J01C (DDD/1000 bed-days)

		2006 (n=28)		2007 (n=55)	
Class	**ATC**	**Mean**	**Range**	**Mean**	**Range**
Combinations of penicillins, inc. beta-lactamase inhibitors	J01CR	174	120 - 280	191	89 - 318
Penicillins with extended spectrum	J01CA	29	13 - 64	31	8 - 68
Beta-lactamase resistant penicillins	J01CF	27	5 - 53	27	1 - 87
Beta-lactamase sensitive penicillins	J01CE	5	0 - 11	5	0 - 12
Total		234	168 - 375	253	100 - 380

4.4.2.3 Cephalosporins, Carbapenems and Monobactams (J01D)

Relative use

In 2007, the relative use of carbapenems (J01DH) and third- (J01DD) and fourth-generation cephalosporins (J01DE) was higher than in 2006, whereas the relative use of first- (J01DB) and second generation (J01DC) cephalosporins and monobactams (J01DF) was lower. First generation cephalosporins were used most, followed by third and second generation cephalosporins. A smaller part was taken by carbapenems and fourth generation cephalosporins (Figure 23).

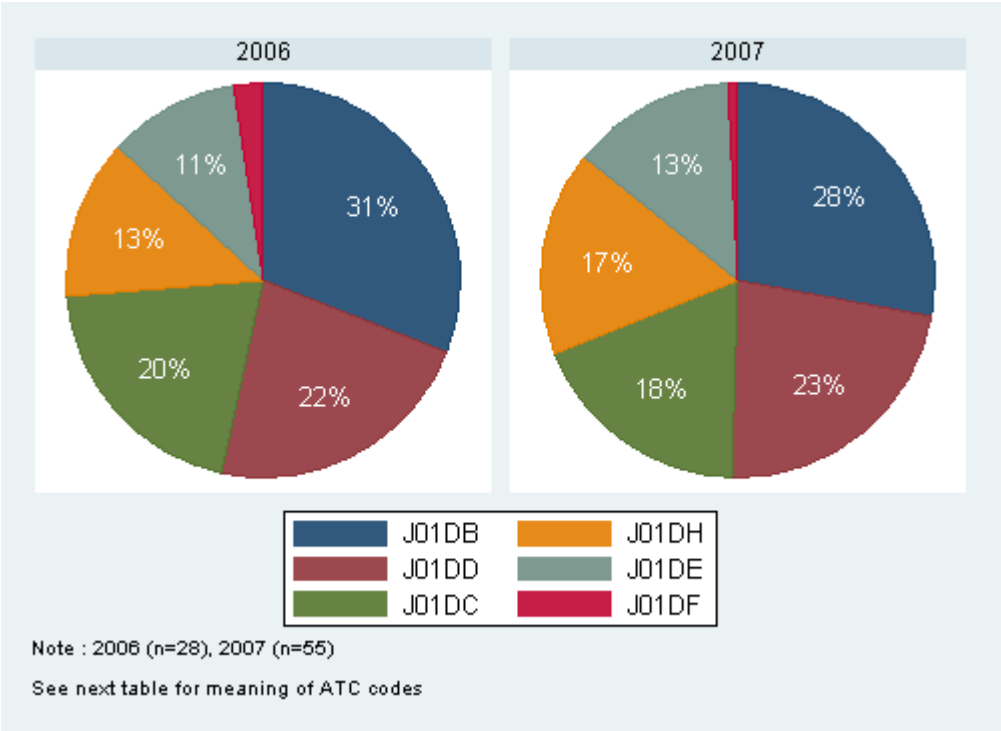


Figure 23 - Distribution of AMD use in the J01D class, 2006 and 2007 **Mean use**

The mean use of cephalosporins, carbapenems and monobactams was 109 and 114 DDD/1000 bed-days for 2006 and 2007, respectively. In general one can observe in 2007 a higher use of drugs with the largest spectrum at the expense of other antibiotics in this group (Table 6).

Table 6 - Use of the subgroups of ATC group J01D (DDD/1000 bed-days)

		2006 (n=28)		2007 (n=55)	
Class	**ATC**	**Mean**	**Range**	**Mean**	**Range**
First-generation cephalosporins	J01DB	34	0 - 91	32	0 - 80
Third-generation cephalosporins	J01DD	24	6 - 54	26	3 - 63
Second-generation cephalosporins	J01DC	22	3 - 61	21	2 - 84
Carbapenems	J01DH	14	3 - 34	19	2 - 64
Fourth-generation cephalosporins	J01DE	12	0 - 39	15	0 - 59
Monobactams	J01DF	3	0 - 48	1	0 - 5
Total		109	39 - 175	114	17 - 244

4.4.2.4 Quinolone antibacterials (J01M)

Relative use

In 2007, the relative use of levofloxacin (J01MA12) was lower (38 vs. 49 %) than in 2006, whereas the relative use of ciprofloxacin (J01MA02) and moxifloxacin (J01MA14) was higher (ciprofloxacin : 41 vs. 36 %, moxifloxacin : 16 vs. 12 %) (Figure 24).

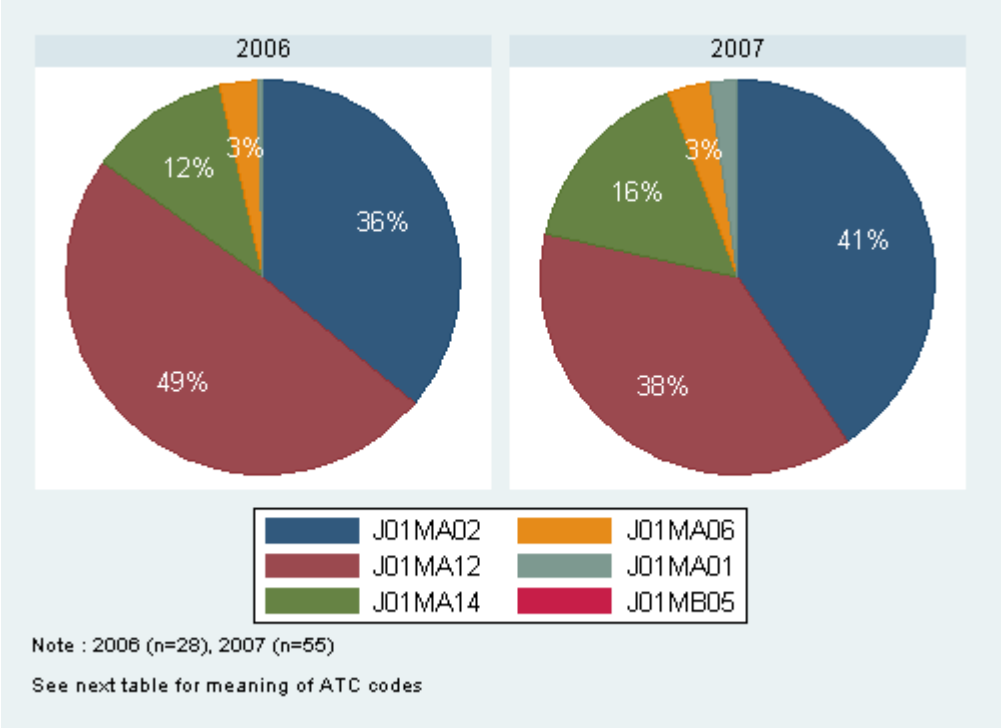


Figure 24 - Distribution of AMD use in the J01M class, 2006 and 2007 **Mean use**

The mean use of quinolones was 65 and 67 DDD/1000 bed-days for 2006 and 2007, respectively. In 2007, the mean use of levofloxacin was lower than in 2006, but the mean use of ciprofloxacin and moxifloxacin were higher (Table 7).

Table 7 - Use of different quinolone antibacterials (DDD/1000 bed-days)

		2006 (n=28)		2007 (n=55)	
Class	**ATC**	**Mean**	**Range**	**Mean**	**Range**
Ciprofloxacin	J01MA02	23	0 - 79	27	0 - 89
Levofloxacin	J01MA12	32	0 - 91	25	0 - 103
Moxifloxacin	J01MA14	7	0 - 19	11	0 - 33
Norfloxacin	J01MA06	2	0 - 11	2	0 - 22
Ofloxacin	J01MA01	0	0 - 3	2	0 - 26
Total		65	8 -102	67	7 - 115

4.4.2.5 Glycopeptide antibacterials (J01XA)

Relative use

In 2007, the relative use of vancomycin (J01XA01) was lower than in 2006, whereas the relative use of teicoplanin (J01XA02) was higher (Figure 25).

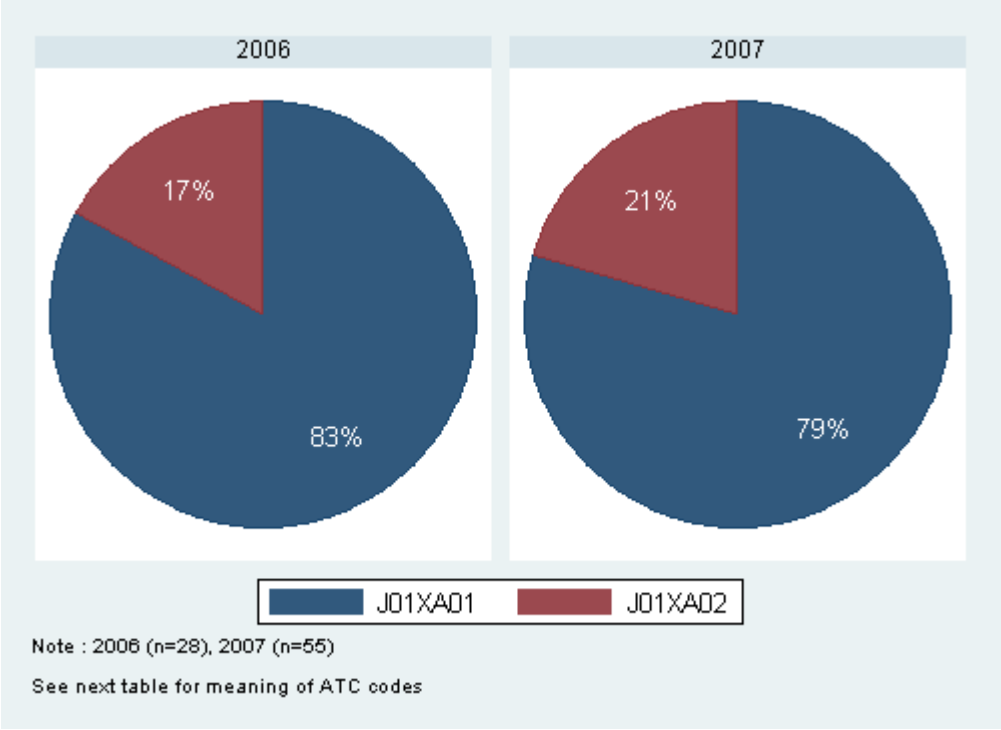


Figure 25 - Distribution of AMD use in the J01XA class, 2006 and 2007

Mean use

The mean use of glycopeptide antibacterials was comparable between 2006 and 2007 (Table 8).

Table 8 - Use of different glycopeptide antibacterials (DDD/1000 bed-days)

		2006 (n=28)		2007 (n=55)	
Class	**ATC**	**Mean**	**Range**	**Mean**	**Range**
Vancomycin	J01XA01	10	0 - 25	10	0 - 35
Teicoplanin	J01XA02	2	0 - 11	3	0 - 31
Total		12	2 - 34	13	2 - 38

4.4.2.6 Antimycotics for systemic use (J02)

Relative use

For 2006 and 2007, the distribution between the different subgroups of the antimycotics for systemic use was almost identical. Triazole derivatives counted for 90% of all antimycotics for systemic use. The relative use of amphotericin B (J02AA) was higher in 2007 compared to 2006 (Figure 26).

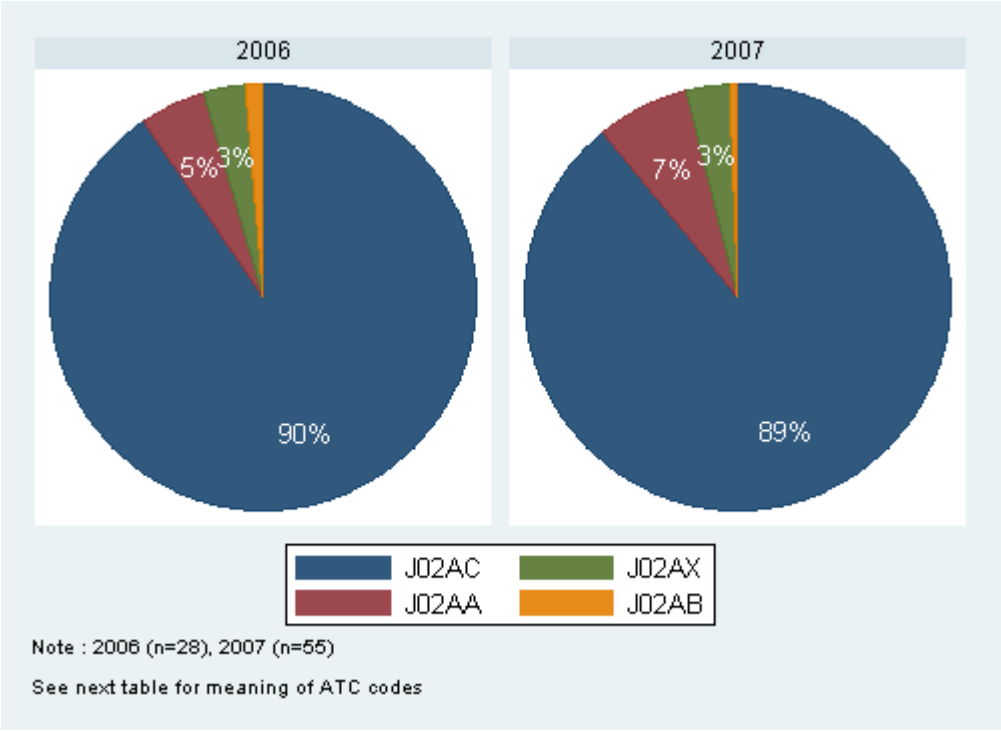


Figure 26 - Distribution of antimycotic use, 2006 and 2007

Mean use

The mean use of antimycotics for systemic use was 25 and 34 DDD/1000 bed-days for 2006 and 2007, respectively (Table 9). This increase of 36% was mainly due to an increased use of triazole derivatives.

Table 9 - Use of the subgroups of ATC group J02A (DDD/1000 bed-days)

		2006 (n=28)		2007 (n=55)	
Class	**ATC**	**Mean**	**Range**	**Mean**	**Range**
Triazole derivatives	J02AC	23	0 - 64	31	0 - 89
Antibiotics (Amphotericin B)	J02AA	1	0 - 7	2	0 - 29
Other antimycotics for systemic use	J02AX	1	0 - 4	1	0 - 11
Imidazole derivatives	J02AB	0	0 - 2	0	0 - 1
Total		25	0 - 72	34	0 - 111

4.5 AMD Use of different subgroups, hospitals participating both in 2006 and 2007

Relative use

The relative part of each subgroup on the ATC-3 level was very similar between 2006 and 2007. We saw a small increase in the relative use of penicillins (J01C) and antimycotics for systemic use (J02A), and a small decrease in the relative use of 'other beta-lactam antibacterials' (J01D) and 'other antibacterials[6]' (Figure 27).

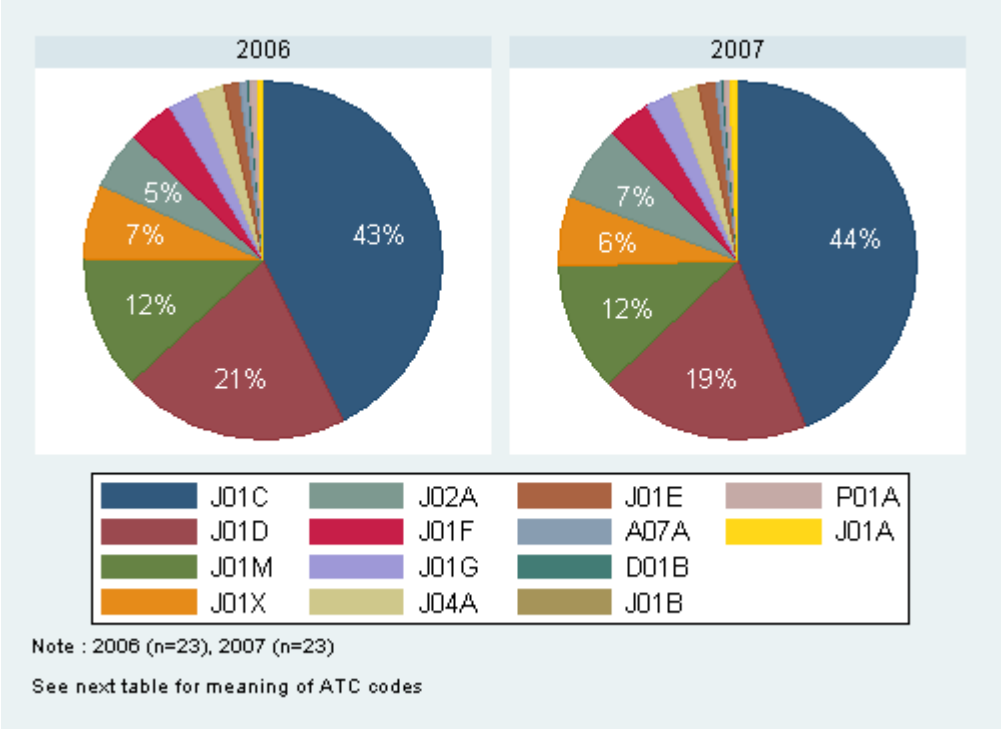


Figure 27 - Distribution of AMD use on ATC-3 level, hospitals participating both in 2006 and 2007

Mean use

The total mean AMD use (DDD/1000 bed-days) of the hospitals participating both in 2006 and 2007 increased slightly (Table 10), mainly due to an increase in the use of penicillins (J01C) and antimycotics for systemic use (J02A). The use of the other beta-lactam antibacterials (J01D) decreased slightly (Figure 28).

For both 2006 and 2007, the penicillins (J01C) are the most used group of antimicrobials, followed by the other beta-lactam antibacterials (J01D), quinolones (J01M) and other antibacterials such as glycopeptides, polymyxins and imidazole derivates (J01X) (Table 10).

[6] Other antibacterials : glycopeptides, polymyxins, steroid antibacterials, imidazole derivatives, nitrofuran derivatives and others

Table 10 - AMD use (DDD/1000 bed-days) per ATC-3 class, hospitals participating both in 2006 and 2007

		2006 (n=23)		2007 (n=23)	
Class	**ATC**	**Mean**	**Range**	**Mean**	**Range**
Beta-lactam antibacterials, penicillins	J01C	246	168 - 375	263	190 - 360
Other beta-lactam antibacterials	J01D	119	39 - 175	114	49 - 159
Quinolone antibacterials	J01M	70	8 - 102	69	7 - 115
Other antibacterials	J01X	39	12 - 61	38	10 - 99
Antimycotics for systemic use	J02A	30	0 - 72	41	0 - 61
Macrolides, lincosamides and streptogramins	J01F	24	8 - 38	24	7 - 40
Aminoglycoside antibacterials	J01G	16	1 - 38	15	1 - 38
Drugs for treatment of tuberculosis	J04A	13	0 - 132	14	1 - 110
Sulfonamides and trimethoprim	J01E	9	1 - 22	9	1 - 29
Intestinal anti-infectives	A07A	4	0 - 21	4	0 - 9
Agents against amoebiasis and other protozoal diseases	P01A	4	0 - 7	4	1 - 13
Tetracyclines	J01A	3	0 - 7	3	1 - 7
Antifungals for systemic use	D01B	1	0 - 6	1	0 - 4
Amphenicols	J01B	0	0 - 1	0	0 - 0
Total		578	347 - 827	600	373 - 789

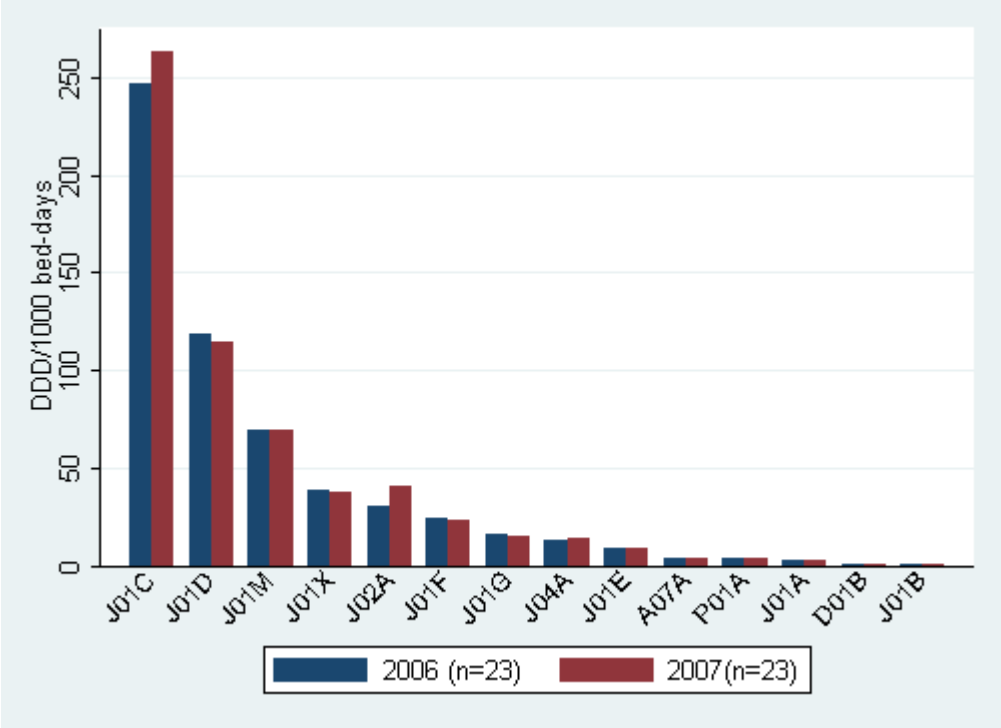


Figure 28 - Mean drug use (DDD/1000 bed-days) per ATC-3 level, hospitals participating both in 2006 and 2007

4.6 Results by hospital unit

4.6.1 All antimicrobials (J01 + J02 + J04A + A07A + P01AB + D01B)

The median AMD use per bed-day was more than twice as high in ICU compared to NPD (1347 vs. 484 DDD/1000 bed-days for 2006 and 1423 vs. 578 DDD/1000 bed-days for 2007). The AMD use in HAO (1122 DDD/1000 bed-days) was a little lower than in ICU. For ICU and HAO more variation was found between hospitals than for NPD both for 2006 and 2007. For 2007, a big increase in variation in ICU was observed (Figure 29).

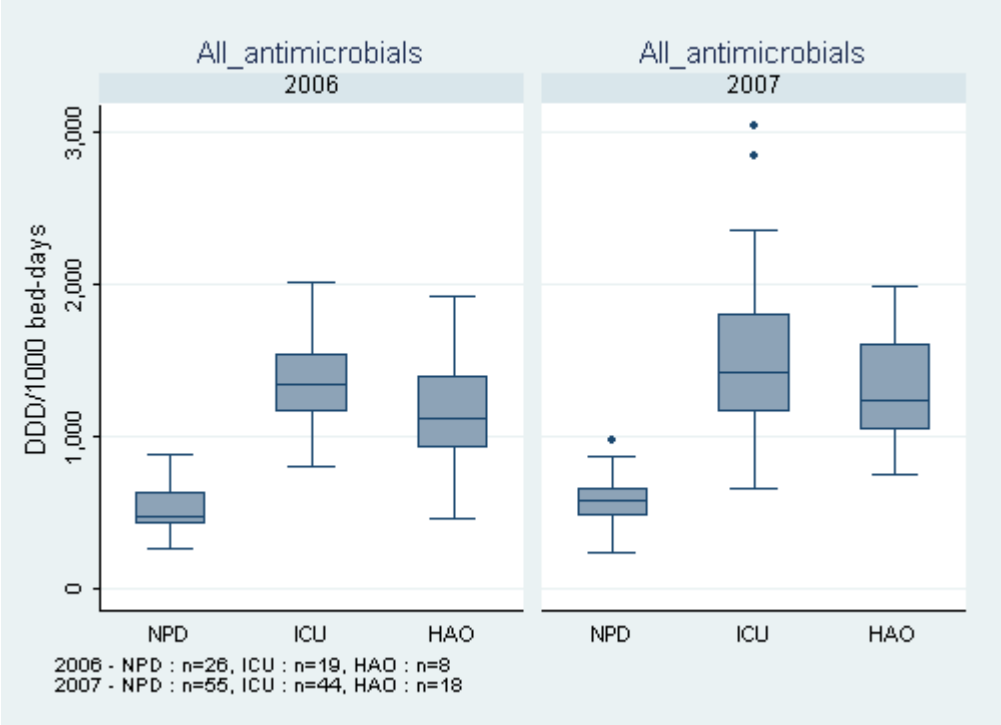


Figure 29 - Antimicrobial use (DDD/1000 bed-days) per unit, 2006 and 2007

When the AMD drug use was expressed as DDD/1000 admissions, several outliers were seen. These mostly concerned wards with a mean duration of stay exceeding 28 days (Figure 30).

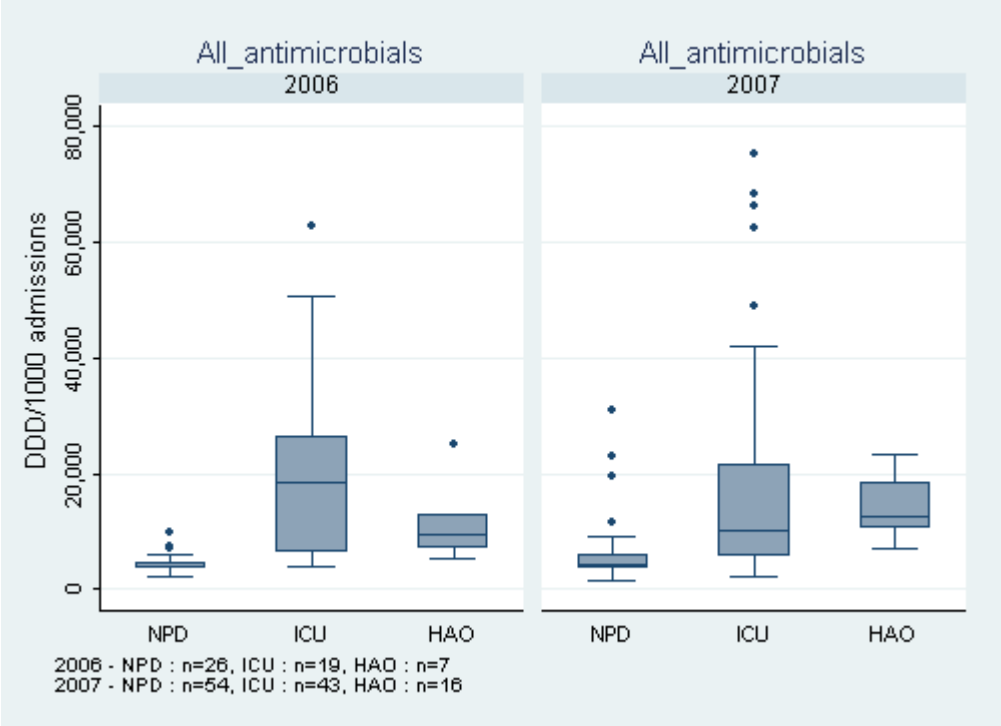


Figure 30 - Antimicrobial use (DDD/1000 admissions) per unit, 2006 and 2007

When expressed as DDA/1000 bed-days, the AMD use on HAO was comparable with the use in ICU (Figure 31). This in contrast with what was seen if the AMD use was expressed as DDD/1000 bed-days (Figure 29). This could be due to a relative high use of drugs with a higher DDA than DDD on ICU compared to HAO.

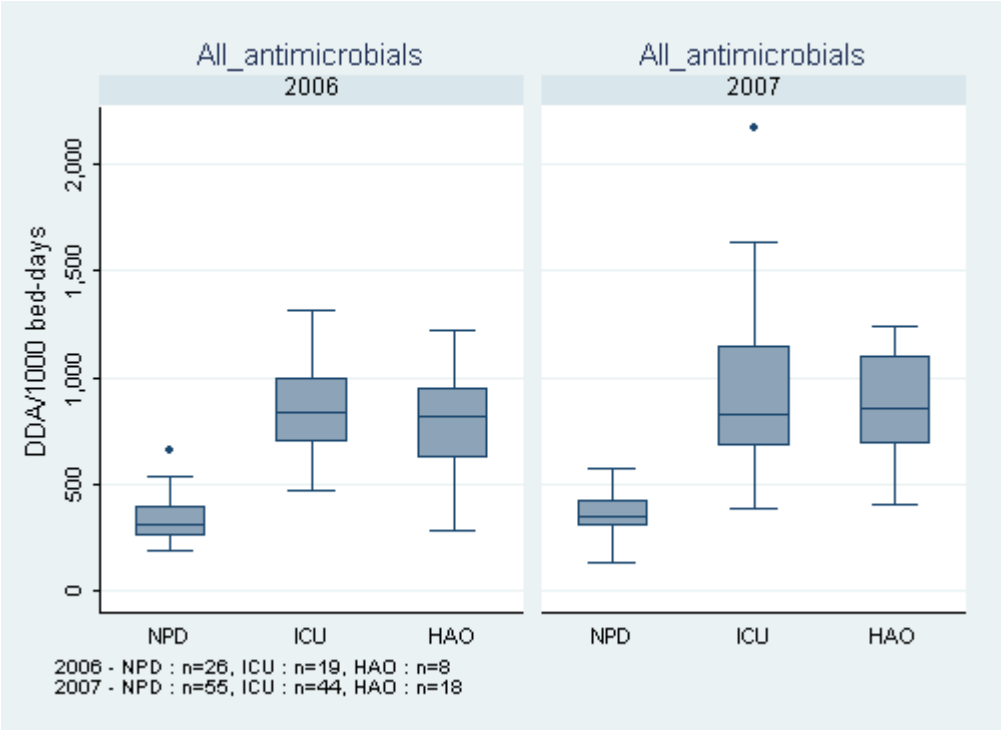


Figure 31 - Antimicrobial use (DDA/1000 bed-days) per unit, 2006 and 2007

When the AMD drug use was expressed as DDA/1000 admissions, several outliers were seen similar to what was seen if the use was expressed as DDD/1000 admissions. These mostly consisted of wards with a mean duration of stay of more than 28 days (Figure 32).

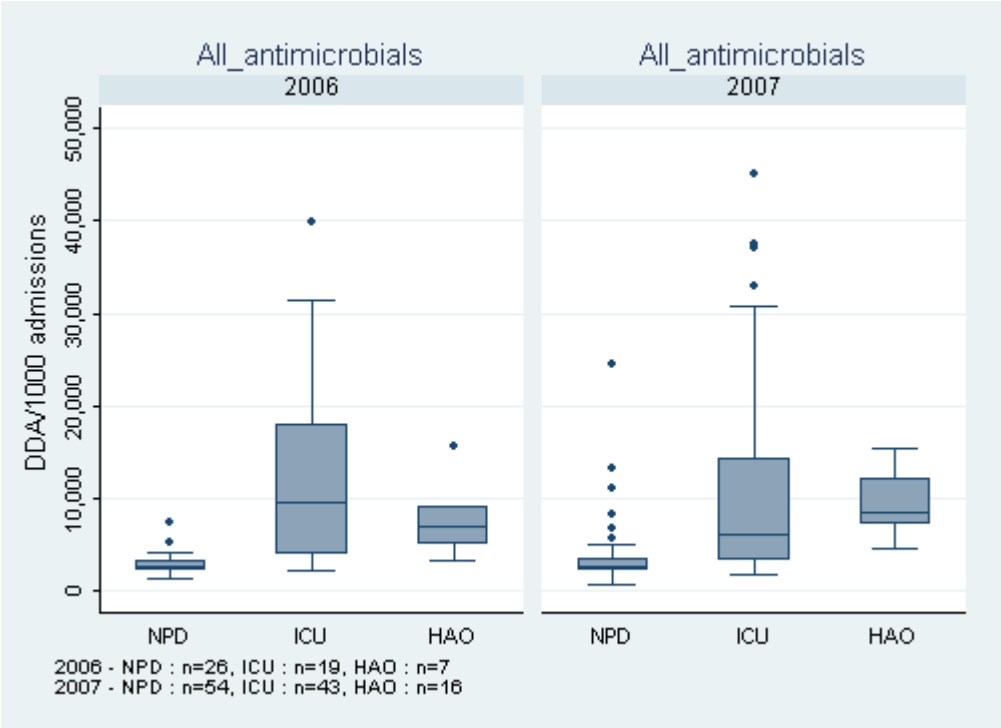


Figure 32 - Antimicrobial use (DDA/1000 admissions) per unit, 2006 and 2007

4.6.2 Antibacterials for systemic use (J01)

The median antibacterial use per bed-day was more than twice as high in ICU compared to NPD (1150 vs. 456 DDD/1000 bed-days for 2006 and 1209 vs. 536 DDD/1000 bed-days for 2007). The median antibacterial use in HAO (787 DDD/1000 bed-days in 2006, 943 DDD/1000 bed-days in 2007) was situated in between the use on NPD and ICU. For 2007, a big increase in variation in ICU was observed (Figure 33).

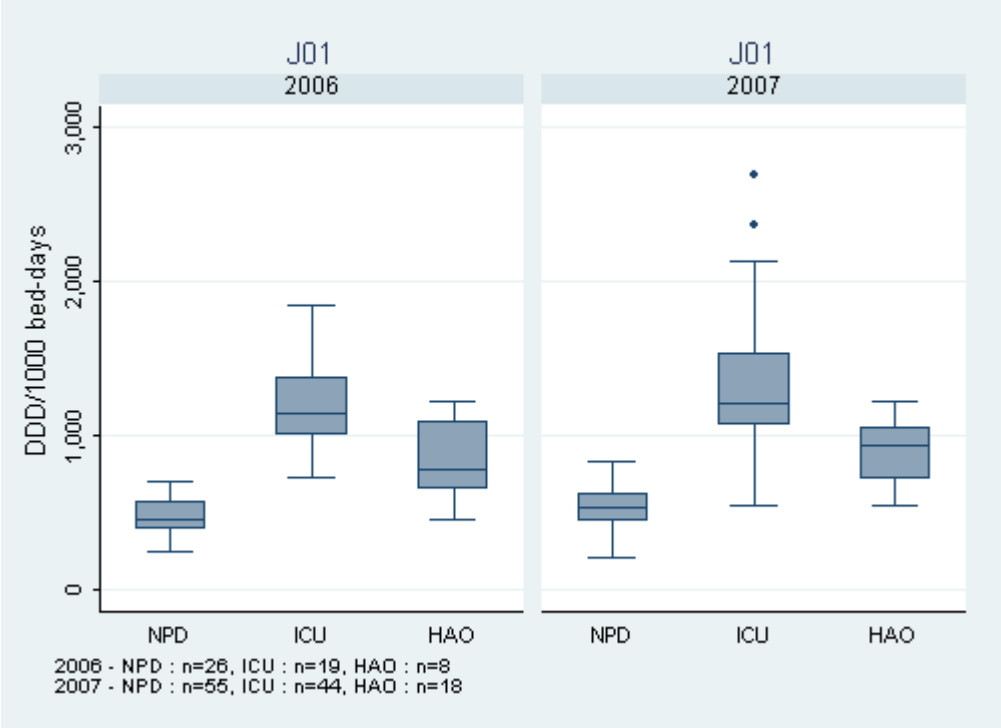


Figure 33 - Antibacterial use (DDD/1000 bed-days) per unit, 2006 and 2007

4.6.3 Antimycotics for systemic use (J02)

The median antimycotic use per 1000 bed-days was more than 14 times as high in HAO compared to NPD (414 vs. 28 DDD/1000 bed-days) in 2007 and even more than 17 times as high in 2006 (142 vs. 21 DDD/1000 bed-days).

The median antimycotic use per 1000 bed-days in ICU lies in between that of NPD and HAO. For 2006 and 2007, it was more than six times as high compared to NPD (142 vs. 21 DDD/1000 bed-days and 194 vs. 28 DDD/1000 bed-days for 2007) (Figure 34).

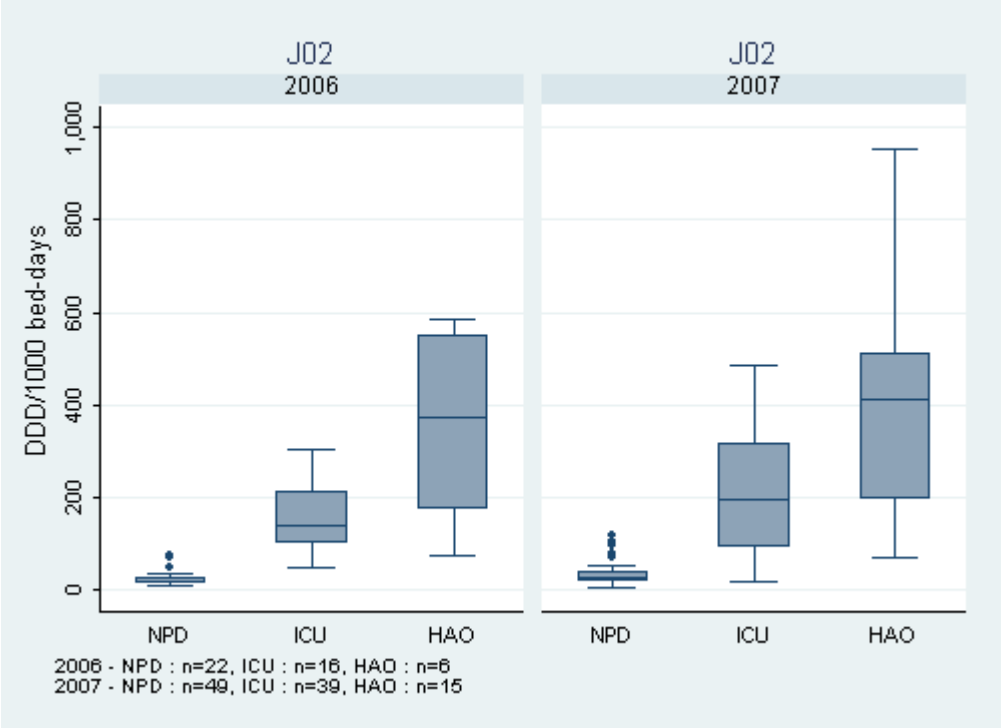


Figure 34 - Antimycotic use (DDD/1000 bed-days) per unit, 2006 and 2007

4.6.4 Tuberculostatics (J04A)

The median use of tuberculostatics per bed-day the highest in ICU (12 DDD/1000 bed-days in 2006, 19 DDD/1000 bed-days in 2007), followed by NPD (8 DDD/1000 bed-days in 2006 and 2007) and was the lowest in HAO (5 DDD/1000 bed-days in 2006, 3 DDD/1000 bed-days in 2007) (Figure 35).

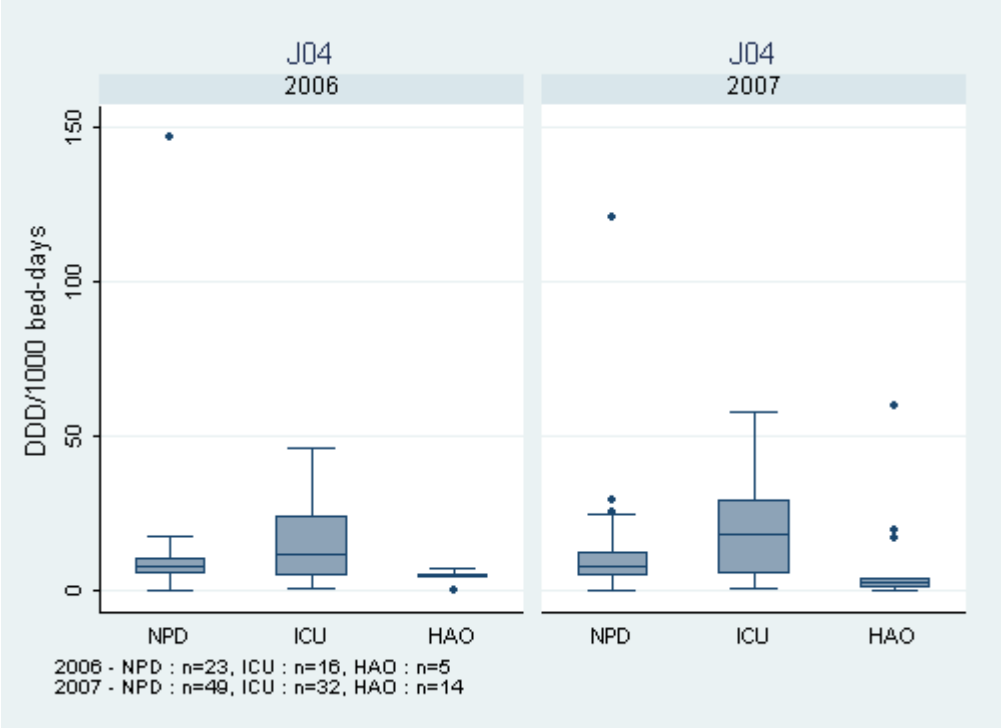


Figure 35 - Use of tuberculostatics (DDD/1000 bed-days) per unit, 2006 and 2007

4.7 Results of stratified analyses

4.7.1 Stratified by level of care

4.7.1.1 Participation

The number of university and non-university hospitals that participated for the different wards, is shown in Table 11. Because of the low number of participating university hospitals in 2006, the stratification by level of care was only done for 2007.

Table 11 - Number of non-university and university hospitals participating, 2006 and 2007

	2006		2007	
	non-university	university	non-university	university
hospital unit				
NPD	23	3	48	7
ICU	16	3	37	7
HAO	5	3	11	7

4.7.1.2 All antimicrobials (J01 + J02 + J04A + A07A + P01AB + D01B)

Median and distribution

Stratified by level of care, it was shown that for 2007 university hospitals had a moderately higher median use on all wards (NPD: 767 vs. 558, ICU: 1492 vs. 1385, HAO: 1397 vs. 1174 DDD/1000 bed-days). The variation in both groups was comparable although there were two outliers in the group of non-university hospitals (Figure 36).

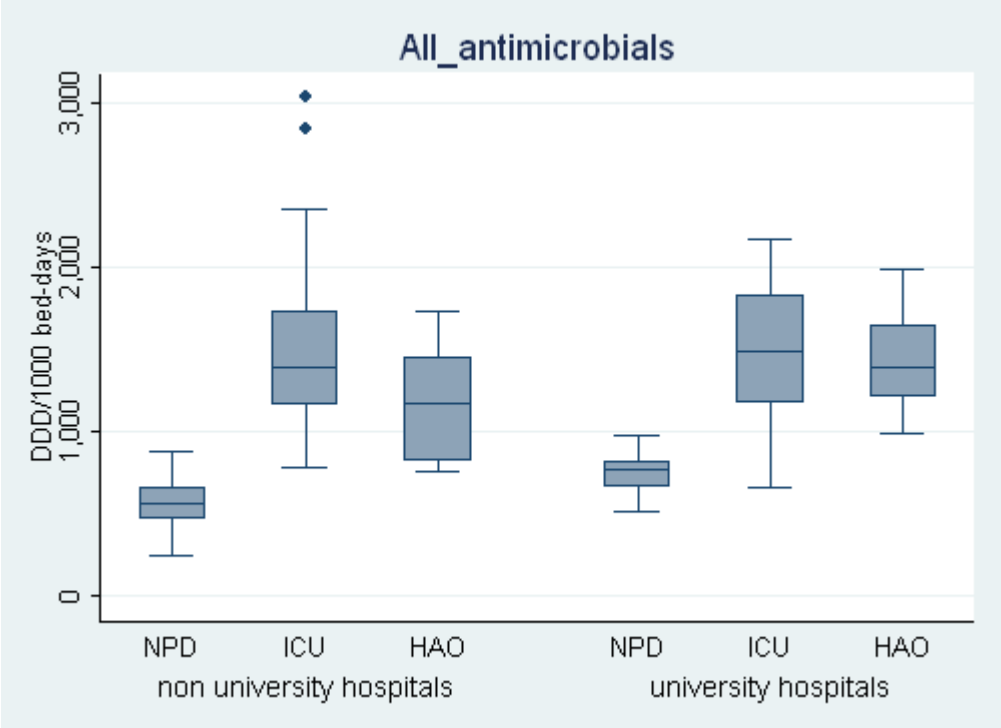


Figure 36 - AMD use (DDD/1000 bed-days) by level of care, 2007

Mean

When looking at the mean AMD use in DDD/1000 bed-days, the AMD use in the NPD and HAO was higher in university hospitals. The AMD use in ICU was almost the same (Table 12).

Table 12 - Mean AMD use (DDD/1000 bed-days) by level of care, 2007

	Mean AMD use (DDD/1000 bed-days)	
	non-university	university
hospital unit		
NPD	536	733
ICU	1440	1470
HAO	1202	1402

4.7.1.3 Antibacterials for systemic use (J01)

Median and distribution

Stratified by level of care, for 2007 it was shown that university hospitals had a moderately higher median use on NPD (672 vs. 524 DDD/1000 bed-days) and HAO (993 vs. 902 DDD/1000 bed-days). The median use in ICU was comparable between university and non-university hospitals (1193 vs. 1216 DDD/1000 bed-days). In the non-university hospitals we observed a few outliers on ICU (Figure 37).

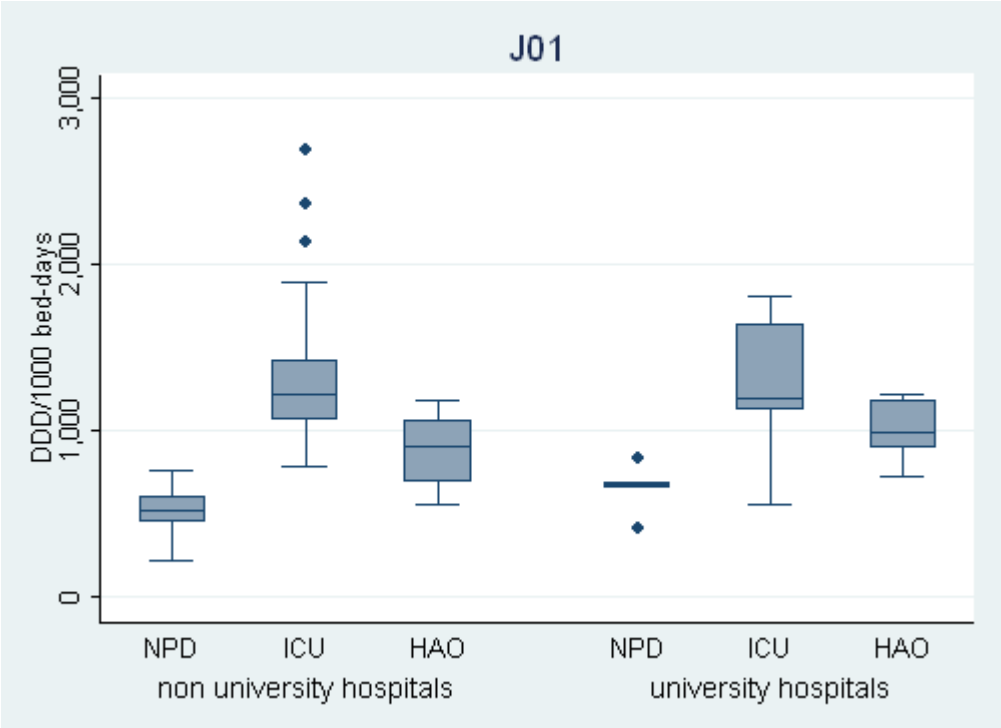


Figure 37 - Antibacterial use (DDD/1000 bed-days) by level of care, 2007

Mean

The mean antibacterial use in NPD and HAO was higher in university hospitals, whereas the antibacterial use in ICU was comparable between university and non-university hospitals (Table 13).

Table 13 - Mean antibacterial use (DDD/1000 bed-days) by level of care, 2007

	Mean antimicrobial use (DDD/1000 bed-days)	
	non-university	university
hospital unit		
NPD	492	640
ICU	1257	1215
HAO	866	929

4.7.1.4 Antimycotics for systemic use (J02)

Median and distribution

Stratified by level of care, one can notice that for 2007 university hospitals had a moderately higher median antimycotic use on all wards (NPD : 80 vs. 24, ICU : 272 vs. 164, HAO : 464 vs. 323 DDD/1000 bed-days) (Figure 38).

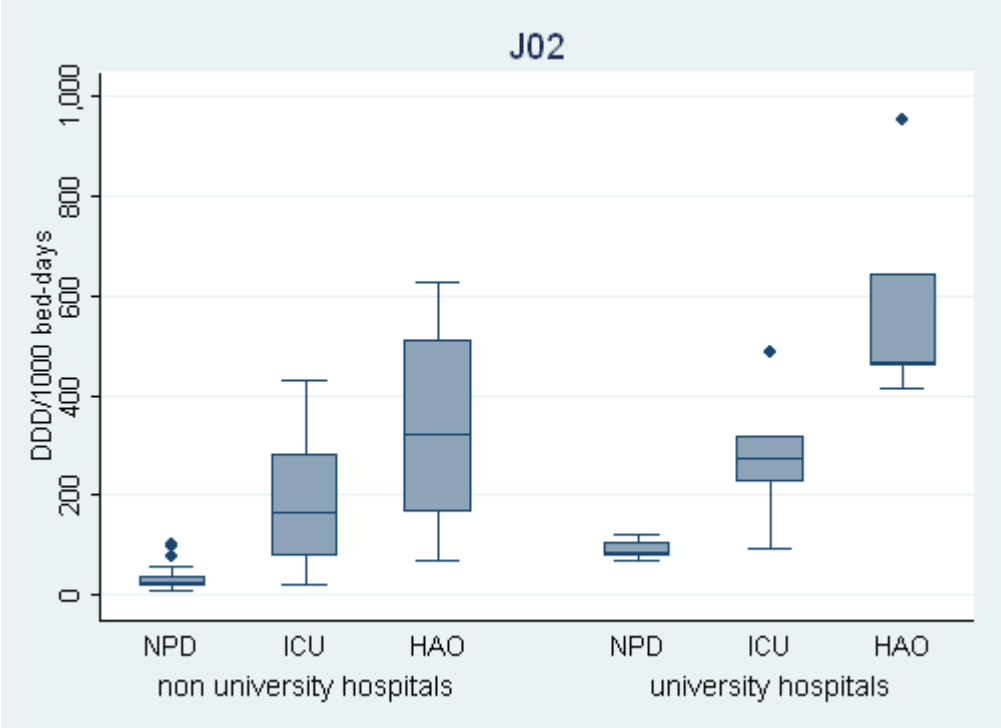


Figure 38 - Antimycotic use (DDD/1000 bed-days) by level of care, 2007

Mean

The antimycotic use in all wards was remarkably higher in university than in non-university hospitals (Table 14).

Table 14 - Mean antimycotic use (DDD/1000 bed-days) by level of care, 2007

	Mean antimycotic use (DDD/1000 bed-days)	
	non-university	university
hospital unit		
NPD	27	69
ICU	157	215
HAO	297	445

4.7.1.5 Tuberculostatics (J04A)

Median and distribution

Stratified by level of care, we saw for 2007 that university hospitals had a higher median use on NPD (18 vs. 7 DDD/1000 bed-days). For ICU and HAO, the median use was comparable (ICU : 20 vs. 18, HAO : 4 vs. 2 DDD/1000 bed-days) (Figure 39).

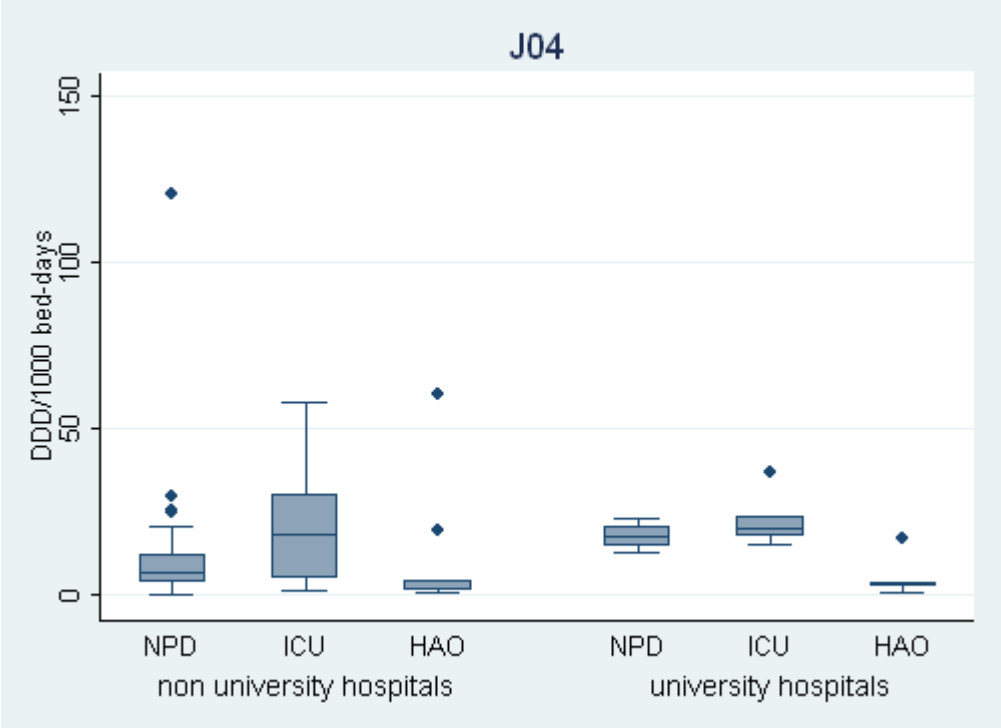


Figure 39 - Use of tuberculostatics (DDD/1000 bed-days) by level of care, 2007

Mean

When looking at the mean use of tuberculostatics in DDD/1000 bed-days, the use of tuberculostatics in university and non-university hospitals was comparable on NPD and ICU (NPD : 13 vs. 11 DDD/1000 bed-days, ICU : 18 vs. 17 DDD/1000 bed-days). On HAO, the

mean use was higher in non-university than in university hospitals (10 vs. 4 DDD/1000 bed-days), due to one severe outlier (Table 15, Figure 39).

Table 15 - Mean use of tuberculostatics by level of care, 2007

	Mean use of tuberculostatics (DDD/1000 bed-days)	
	Non-university	university
hospital unit		
NPD	11	13
ICU	17	18
HAO	10	4

4.7.2 Stratified by hospital size

4.7.2.1 Participation

The number hospitals stratified by size that participated for the different units, is shown in Table 16. Because of the low numbers of participating hospitals with more than 800 beds in 2006, the stratified analysis by hospital size is only done for 2007.

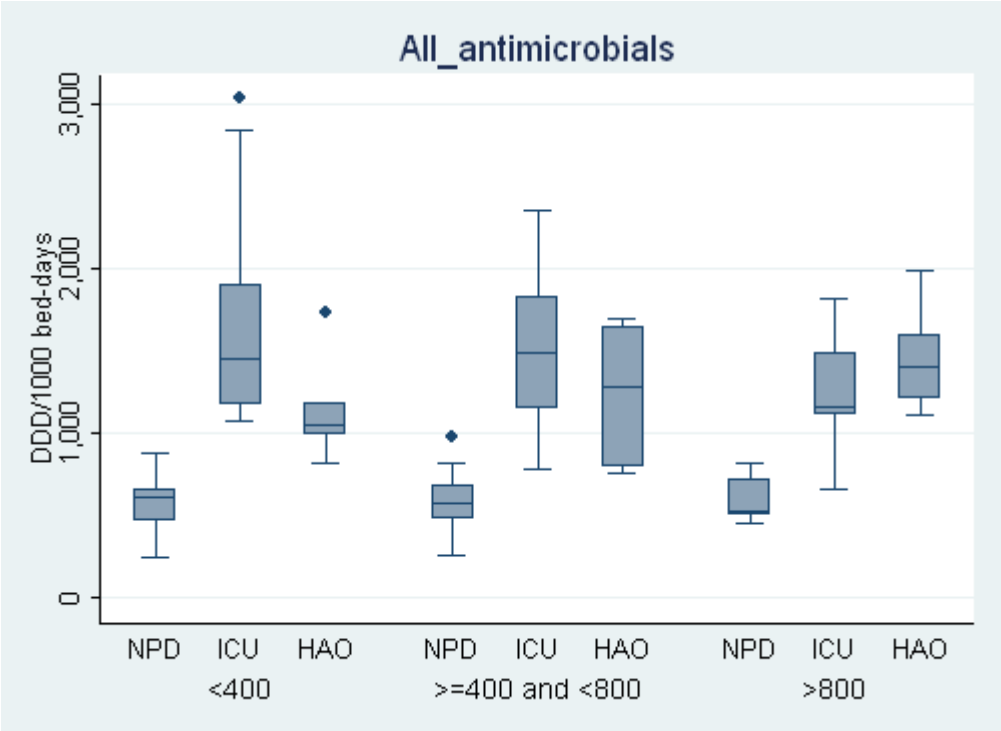
Table 16 - Number of participating hospitals according to size, 2006 and 2007

	2006			2007		
	<400 beds	>=400 and <800 beds	>=800 beds	<400 beds	>=400 and <800 beds	>=800 beds
hospital unit						
NPD	13	11	2	30	17	8
ICU	9	8	2	22	15	7
HAO	2	4	2	5	6	7

4.7.2.2 All antimicrobials (J01 + J02 + J04A + A07A + P01AB + D01B)

Median and distribution

Stratified by hospital size, a comparable AMD use for NPD was seen over the different groups. Hospitals with more than 800 beds had the lowest median AMD use in ICU. Small and medium sized hospitals had a comparable AMD use in ICU wards but the distribution was positively skewed among the small hospitals. Due to the low number of observations, it was difficult to draw conclusions about AMD use in HAO (Figure 40).



it

Figure 40 - AMD use (DDD/1000 bed-days) by hospital size, 2007

Mean

When looking at the mean AMD use in DDD/1000 bed-days, we observed that hospitals with > 800 beds have the lowest mean use in ICU (Table 17).

Table 17 - Mean AMD use by hospital size, 2007

	DDD/1000 bed-days		
	number of beds		
	< 400	*≥ 400 and <800*	*≥ 800*
hospital unit			
NPD	552	581	616
ICU	1549	1572	1277
HAO	1110	1307	1389

4.7.2.3 Antibacterials for systemic use (J01)

Median and distribution

Stratified by hospital size, for all 3 units the median antibacterial use was the lowest in hospitals with more than 800 beds, followed by medium sized hospitals (400-800 beds and the highest in hospitals with less than 400 beds. The difference between medium sized hospitals and large hospitals was bigger than the difference between small and medium sized hospitals (Figure 41).

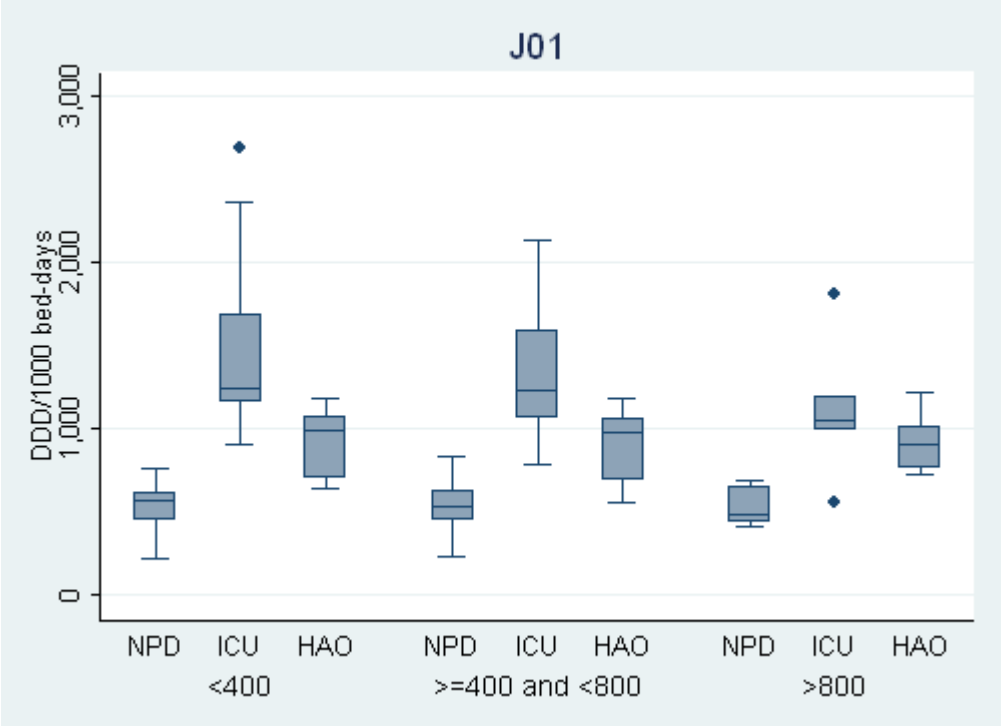


Figure 41 - Use of antibacterials (DDD/1000 bed-days) by hospital size, 2007

Mean

When looking at the mean antimicrobial use in DDD/1000 bed-days, we observed that hospitals with > 800 beds have the lowest mean use in ICU and HAO, but not in NPD (Table 18).

Table 18 - Mean antibacterial use (DDD/1000 bed-days) stratified by hospital size, 2007

	DDD/1000 bed-days		
	number of beds		
	< 400	≥ 400 and <800	≥ 800
hospital unit			
NPD	514	523	543
ICU	1346	1328	1094
HAO	902	933	876

4.7.2.4 Antimycotics for systemic use (J02)

Median and distribution

Stratified by hospital size, hospitals of different size had a comparable median antimycotic use for NPD. Hospitals with more than 800 beds had the lowest median antimycotic use in ICU but the highest in HAO (Figure 42).

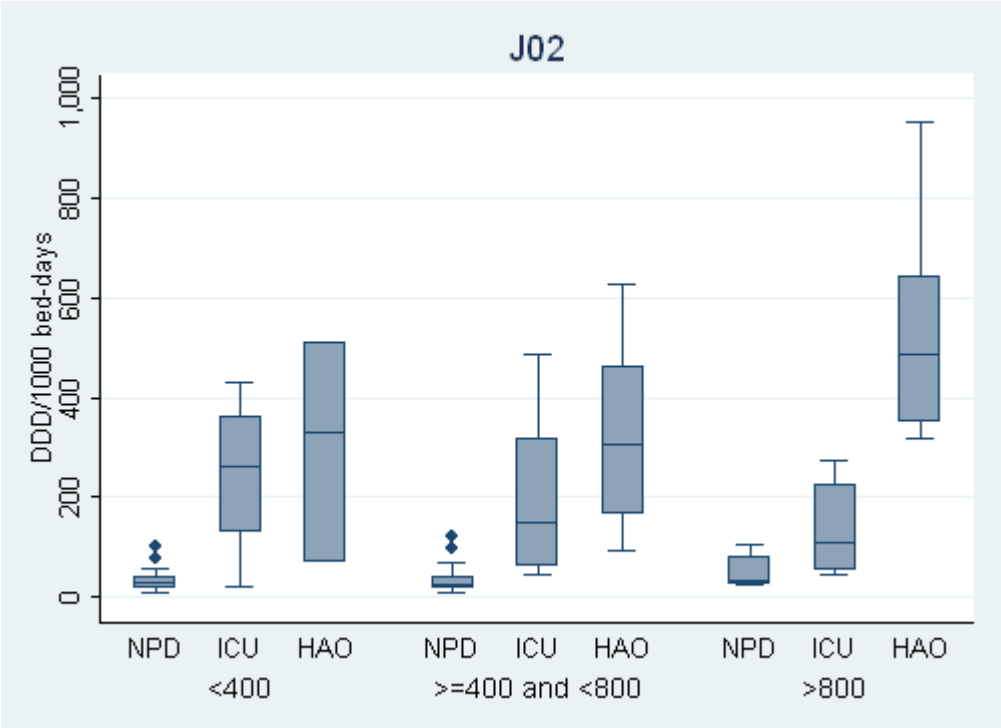


Figure 42 - Use of antimycotics (DDD/1000 bed-days) by hospital size, 2007

Mean

When looking at the mean antimycotic use in DDD/1000 bed-days, we observed that hospitals with > 800 beds have the lowest mean use in ICU but the highest in HAO (Table 19).

Table 19 - Mean antimycotic use (DDD/1000 bed-days) stratified by hospital size, 2007

	DDD/1000 bed-days		
	number of beds		
	< 400	≥ 400 and <800	≥ 800
hospital unit			
NPD	26	35	51
ICU	186	210	145
HAO	163	360	473

4.7.2.5 Tuberculostatics (J04A)

Median and distribution

Stratified by hospital size, small hospitals had a lower use on ICU than medium sized or large hospitals, whereas the use on HAO was remarkable higher (Figure 43).

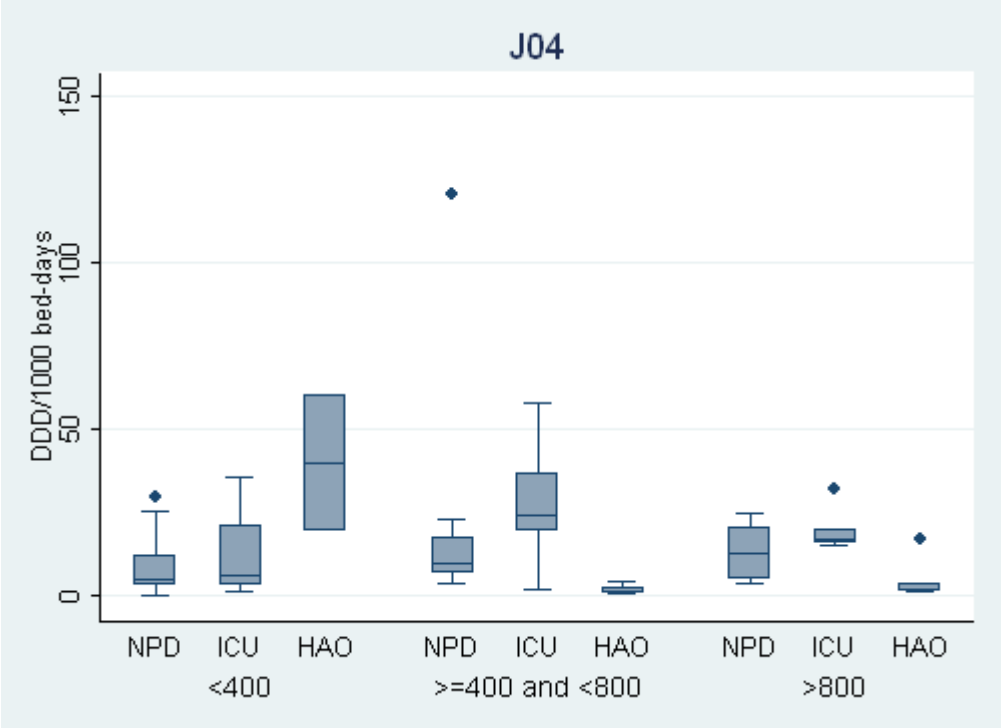


Figure 43 - Use of tuberculostatics (DDD/1000 bed-days) by hospital size, 2007

Mean

When looking at the mean use of tuberculostatics in DDD/1000 bed-days, it can be observed that the use on NPD and ICU was the highest in medium sized hospitals whereas on HAO the highest use was seen in small hospitals (Table 20).

Table 20 - Mean use of tuberculostatics (DDD/1000 bed-days) stratified by hospital size, 2007

	DDD/1000 bed-days		
	number of beds		
	< 400	≥ 400 and <800	≥ 800
hospital unit			
NPD	6	16	12
ICU	7	27	17
HAO	21	2	5

4.8 Oral versus parenteral use

All concerned molecules were administered less frequently orally in ICU compared to NPD. In HAO on the other hand, several molecules were administered more often orally compared to NPD. For 2007 these molecules were: fluconazole, ciprofloxacin, voriconazole, levofloxacin, moxifloxacin, ofloxacin and rifampicin. The percentage of amoxicillin administered orally was much higher for all units in 2006 than in 2007. Also, the percentage of ofloxacin used orally in ICU was much higher in 2006 than in 2007 (Figure 44, Figure 45). For amoxicillin, this relative decrease in oral use resulted from a substantial absolute increase of the parenteral use of amoxicillin in 2007. This increase could be largely attributed to a higher absolute parenteral use in the group of hospitals that participated already in 2006, and was most striking in ICU.

The relative decrease of oral ofloxacin could be explained by an absolute higher use of parenteral ofloxacin by hospitals participating for the first time in 2007. The total use of ofloxacin was however very low, hence small changes in the absolute parenteral use had a large effect on the percentage oral use.

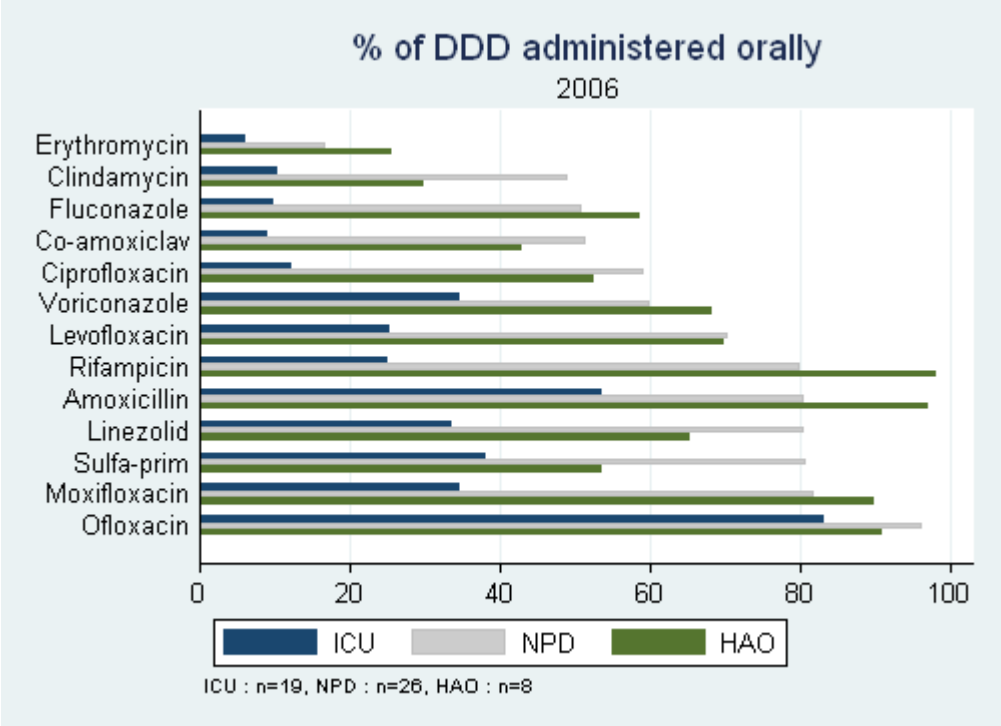


Figure 44 - Percentage of oral use for several molecules, comparison between wards, 2006

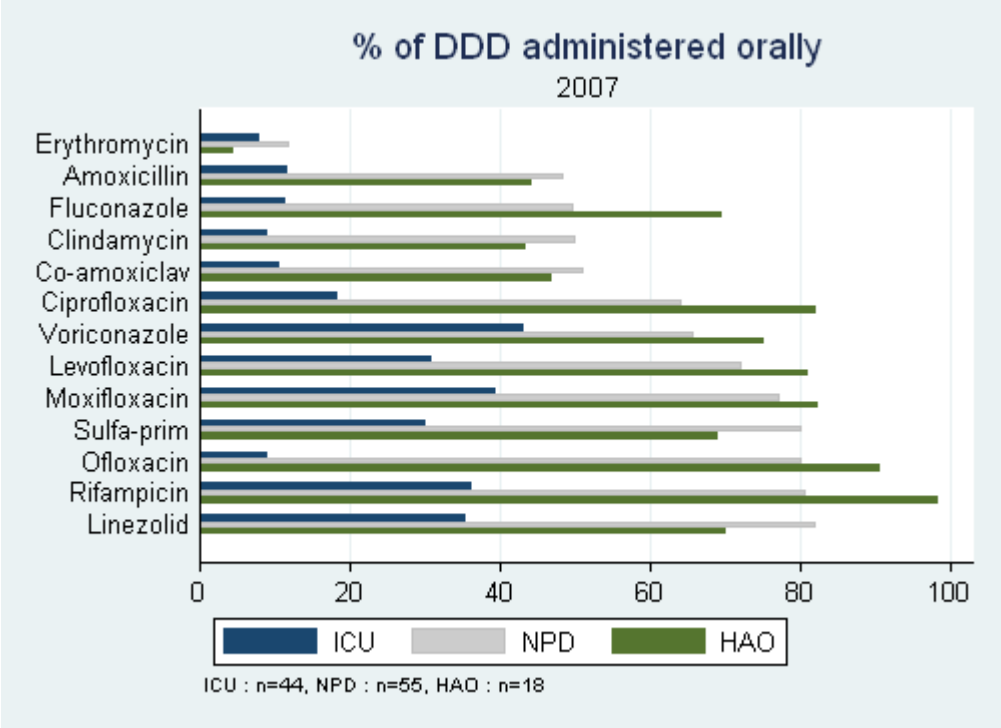


Figure 45 - Percentage of oral use for several molecules, comparison between wards, 2007

4.9 Antibacterial use at intensive care units

The total average antibacterial use in ICU was more than twice as high as in NPD. Except for tetracyclines, the use of all therapeutic groups of antibacterials was higher in ICU (Table 21).

Table 21 - Non-pediatric use versus intensive care use (DDD/1000 bed-days), 2007

Class	ATC	NPD (n=55)	ICU (n=45)
Tetracyclines	J01AA	3	2
Penicillins with extended spectrum	J01CA	26	63
Beta-lactamase sensitive penicillins	J01CE	5	9
Beta-lactamase resistant penicillins	J01CF	27	66
Combinations of penicillins, incl. beta-lactamase inhibitors	J01CR	195	339
First-generation cephalosporins	J01DB	34	60
Second-generation cephalosporins	J01DC	21	37
Third-generation cephalosporins	J01DD	24	87
Fourth-generation cephalosporins	J01DE	15	82
Carbapenems	J01DH	20	131
Sulfonamides and trimethoprim	J01E	9	23
Macrolides	J01FA	16	49
Lincosamides	J01FF	9	11
Aminoglycosides	J01GB	14	61
Quinolones	J01M	70	115
Other antibacterials	J01X	37	99
Total	J01	525	1242

As expected, the use of piperacillin with tazobactam, 3rd and 4th generation cephalosporins and carbapenems was especially concentrated in ICU (Figure 46, Figure 47).

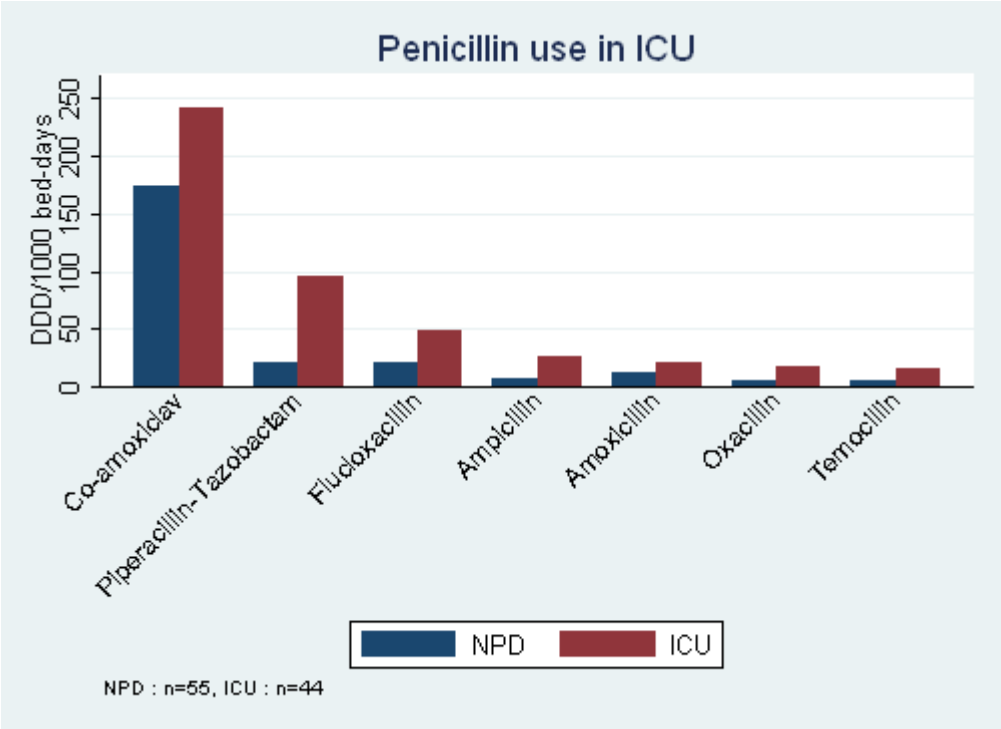


Figure 46 - Use of penicillins in ICU compared with total non-pediatric use (2007)

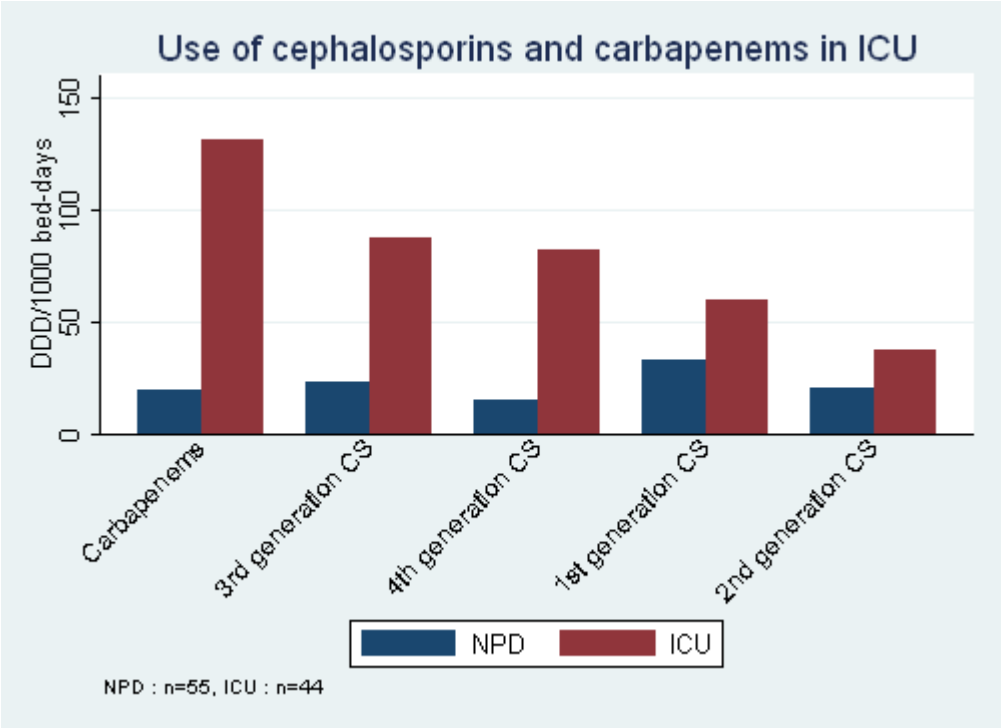


Figure 47 - Use of cephalosporins and carbapenems in ICU compared with total non-pediatric use (2007)

5 Discussion

This surveillance started in 2006. The first participants were hospitals receiving public funding for an antibiotic policy deputy since 2002 (37 hospitals in total, of which 28 participated). They were asked to upload their 2006 consumption and denominator data on a voluntary basis. In 2008 participation in this surveillance became compulsory for all hospitals receiving public funding for an antibiotic policy deputy since 2002 or 2006 (61 hospitals in total of which 55 participated). These hospitals had to report their AMD use for 2007. Because of this difference between participants, a meaningful comparison of the national results over 2006 and 2007 was not straight forward.
The required denominator data are limited to a minimum to keep the surveillance as user friendly as possible. Separate reporting for different wards was largely optional and no clinical or caseload data were requested. This limited the possibilities of interpretation at the national level. It should moreover be noted that the DDD methodology is unsuited for the analysis of pediatric data which is the main reason why separate reporting for pediatric and non-pediatric wards was required. In the future, analyzing pediatric data by means of DDA will be explored.

In general an increase in the AMD use was seen over the two consecutive years. This was seen both when all participating hospitals were included (Figure 2) and when only the group of hospitals that participated in both years (Figure 10) was included in the analyses. The increase in AMD use was mainly due to an increased use of penicillins (J01C) and antimycotics for systemic use (J02A) (Table 10).
The median AMD use in DDD/1000 bed-days was more than twice as high in ICU than in NPD. The use in HAO was lower than in ICU (Figure 29).
University hospitals had a higher AMD use on all wards compared to non-university hospitals. The difference was most prominent in NPD (Figure 36, Table 12). This could be due to a higher number of severe pathologies in university hospitals, especially in wards other than ICU or HAO. Furthermore large hospitals had a lower AMD use in ICU than small and medium sized hospitals, in contrast to the AMD use in NPD which was comparable between hospitals of all sizes (Figure 40). This could indicate that large hospitals follow other antibiotic policies than small hospitals.
For now, no stratification for length of stay was done because of the limited number of hospitals with a high length of stay. In the future a separate analysis might be useful, especially if the number of participating hospitals increases.

The observed decreased percentage oral amoxicillin use in 2007 is due to an absolute increase of the use of parenteral amoxicillin, especially in the group of hospitals that already participated in 2006 (Figure 44, Figure 45).

6 Conclusion

The web module served as a useful tool for hospitals to monitor their AMD consumption. On the national level, a small increase in the total AMD use was seen, mainly due to an increase in the use of penicillins (J01C) and antimycotics for systemic use (J02A). Small and medium sized hospitals had a higher AMD use in ICU than large hospitals. Encouraging the prudent use of antibiotics and stimulating the work of the antibiotic policy groups remains important. The difference in AMD use according to hospital size might need extra attention to enhance antibiotic policies. Also, relationships between AMD use and regimens (formulation, dose, duration, treatment interval) and antibiotic resistance and incidence of nosocomial infections in Belgian hospitals need to be investigated.

By the continuous surveillance of antimicrobial consumption via the web module and by publishing national reports, the authors hope to provide information that can help at the local (hospital) and larger level (public health authorities) to address central questions in the development of guidelines for nosocomial infection control and prevention.

Conflicts of interest

None to declare

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