National Report on
Consumption of Systemic Antimicrobial Agents
in Belgian Hospitals

2007 - 2013
This report was made possible thanks to the participation of most Belgian acute hospitals and large chronic care hospitals to the surveillance. We would like to thank all healthcare professionals who, on behalf of their institutions, devoted time, efforts and patience in order to provide us with the required data.

We are also very grateful to all the professionals involved locally in their hospitals, antimicrobial stewardship programme teams and/or infection control teams, who in the course of the fight against the spread of bacterial resistance, contacted us to share their suggestions, questions, concerns and advices in order to improve the surveillance.

Special thanks to the representatives and members of the Working Group “Hospital Medicine” who guided us in the elaboration of the national report.

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Nota Bene:
Despite all the care that the authors have brought during the elaboration of this report and appendices, some mistakes or errors might have escaped from their attention. Should you point out such errors, or should you have questions or comments concerning these results, please feel free to contact the redaction team, especially the main author, Anne.Ingenbleek@wiv-isp.be.

Thank you.
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### List of abbreviations

<table>
<thead>
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<th>Abbreviation</th>
<th>Description</th>
</tr>
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<tbody>
<tr>
<td>AB</td>
<td>AntiBacterial agents</td>
</tr>
<tr>
<td>ABC</td>
<td>AntiBacterial agents Consumption</td>
</tr>
<tr>
<td>AM</td>
<td>AntiMicrobial agents</td>
</tr>
<tr>
<td>AMC</td>
<td>AntiMicrobial agents Consumption</td>
</tr>
<tr>
<td>AMT</td>
<td>Antimicrobial Management Team</td>
</tr>
<tr>
<td>ATC</td>
<td>Anatomical Therapeutic Chemical (classification system)</td>
</tr>
<tr>
<td>BAPCOC</td>
<td>Belgian Antibiotics Policy COordination Committee</td>
</tr>
<tr>
<td>1GC</td>
<td>1&lt;sup&gt;st&lt;/sup&gt;-Generation Cephalosporins</td>
</tr>
<tr>
<td>2GC</td>
<td>2&lt;sup&gt;nd&lt;/sup&gt;-Generation Cephalosporins</td>
</tr>
<tr>
<td>3GC</td>
<td>3&lt;sup&gt;rd&lt;/sup&gt;-Generation Cephalosporins</td>
</tr>
<tr>
<td>4GC</td>
<td>4&lt;sup&gt;th&lt;/sup&gt;-Generation Cephalosporins</td>
</tr>
<tr>
<td>DDA</td>
<td>Daily Dose Administered</td>
</tr>
<tr>
<td>DDD</td>
<td>Defined Daily Dose</td>
</tr>
<tr>
<td>HAO</td>
<td>HAematology and/or Oncology units</td>
</tr>
<tr>
<td>ICU</td>
<td>Intensive Care Units</td>
</tr>
<tr>
<td>IQR</td>
<td>InterQuartile Range</td>
</tr>
<tr>
<td>IT</td>
<td>Information Technologies</td>
</tr>
<tr>
<td>FPS</td>
<td>Federal Public Service Health, Food Chain Safety &amp; Environment (equivalent to a Ministry of Health)</td>
</tr>
<tr>
<td>FQ</td>
<td>FluoroQuinolones</td>
</tr>
<tr>
<td>LoS</td>
<td>Length of Stay</td>
</tr>
<tr>
<td>MDRO</td>
<td>Multi-Drug Resistant Organism</td>
</tr>
<tr>
<td>NPD</td>
<td>Non-Paediatric Departments</td>
</tr>
<tr>
<td>P</td>
<td>Percentile</td>
</tr>
<tr>
<td>PED</td>
<td>PaEDiatic wards</td>
</tr>
<tr>
<td>TOT</td>
<td>TOTal (hospital-wide: all hospital departments and wards surveyed)</td>
</tr>
<tr>
<td>WHO</td>
<td>World Health Organization</td>
</tr>
<tr>
<td>WIV-ISP</td>
<td>Wetenschappelijk Instituut Volksgezondheid – Institut scientifique de Santé Publique</td>
</tr>
</tbody>
</table>

1 The antibacterial agents are grouped in the class J01 of the ATC/DDD index (cfr. 2.Objectives of the surveillance and footnote).
2 The antimicrobial agents belong to several classes of the ATC/DDD index: J01, J02, J04, J05, A07, D01, P01, P02 (ibidem).
Executive summary

About 90% of acute hospitals have properly delivered their antimicrobial consumption (AMC) data to the surveillance BeH-SAC. The data have been analysed at the national level, per category of size, per academic status and per level of healthcare. The participation of large chronic hospitals is fragmentary, which hamper surveying those settings at the national level. The average length of stay (LoS) in acute hospital is decreasing from year to year; this is particularly observable in non-paediatrics departments (NPD), and in NPD of small and primary hospitals.

After several years of regular increase, 2013 shows, both in terms of daily consumption and in terms of consumption over a stay, a decrease in the overall antibacterial agents (J01) use in acute hospitals as compared to the previous year (-3.1% and -8.4% respectively). In 2013, the 2013 median hospital-wide antibacterial consumption (ABC) in acute facilities was 544 DDD / 1000 patient-days or 3609 DDD / 1000 admissions. The combinations of penicillins with an enzyme inhibitor (J01CR) form nearly 40% of the total antibacterial (J01) use and are the most used ATC-subclass in acute hospitals. They are followed by the fluoroquinolones (J01MA) representing about 1/8th of the total antibacterial use. The first-generation cephalosporins (J01DB), the penicillins with expended spectrum (J01CA) and the class of “other antibiotics” (J01X) cover each 6 to 7% of the total J01 use. The decrease of AMC use seen in 2013 is mostly due to an important drop of use of J01CR in general (or primary) hospitals. General hospitals with teaching missions (also called secondary hospitals) appear to be the place where the decrease in the global antibacterial consumption is more evident. The ABC in teaching (tertiary) hospitals is significantly higher than in the other hospitals. The analysis of the appropriateness of AM use cannot be performed based on these surveillance data; for such a perspective, a more specific data collection or data source need to be operated.

Intensive care units (ICUs) of academic hospitals show an AMC per stay which is more than four times higher than the AMC in non-academic hospitals. In haematology and oncology units (HAO), the AMC per stay from 2007 to 2013 is presenting a clear and regular decrease in general hospitals, but an uneven increase in secondary and in tertiary hospitals. Interpreting results for those highly-specialised wards anyway require caution. Analyses for paediatrics are difficult to draw, because several factors of interpretation (like the age and an appropriate measure of treatment for children) are missing in the surveillance BeH-SAC.

The surveillance enables on the contrary to identify which products and molecules are most used and whether their use is increasing with the time. In such a situation, the pressure of selection is maximized, fuelling the risk to generate and spread antimicrobial resistance. High variability of AMC within the same category of hospitals indicates possible improvements to be brought through antimicrobial stewardship programmes. The surveillance BeH-SAC does not have the means to assess the quality of the prescriptions made in hospitals, but provides grounded figures based on which experts from the Belgian Antibiotic Policy Coordination Committee can establish thresholds, targets and indicators of good practices meaningful in Belgium.

As antimicrobial stewardship programmes are still recently developed strategies, further international research and validations need to be launched and achieved concerning the methodological approaches and tools to be used in this field.
1. Introduction

Is it still needed to repeat that the phenomenon of antimicrobials resistance has reached worrying proportions, as various resistant germs are spreading throughout countries, in the hospital sector as well as in the ambulatory sector? [1,2,3] Not to health professionals, for sure. But it might be relevant to underline that fighting against this global health threat requires permanent efforts and a coordinated long-term implementation of multidisciplinary strategies [4,5,6,7] aiming at reducing selective pressure exerted by antimicrobial agents on the one hand and at containing the dissemination of resistant pathogens on the other hand [6,8,9], in the community and in hospitals [2,5,9], in long-term care facilities [10] as well as in animal husbandry [4,11,12]. In the ambulatory sector, such strategies will intend, for instance, at raising both the general public and the practitioners’ awareness regarding the proper use of antimicrobial drugs. In the healthcare sector, great endeavours are expected in order to circumscribe healthcare-associated infections and set up efficient antimicrobial stewardship programmes [8,13].

Since 1999, Belgium has implemented and is funding a body at the federal level, the Belgian Antibiotic Policy Coordination Committee (BAPCOC), whose country-wide overall aim is to hamper and contain the spread of antimicrobial resistances [14,15]. The BAPCOC has launched public education campaigns on antibiotic use and on hand hygiene, edited national treatment guidelines for general and hospital health practitioners, promoted and supports hospital antimicrobial management teams (AMTs) [14,15]; it gathers medical and scientific expertise to define adequate national policies; it also carries out studies, trainings and strategic evaluations in healthcare settings at the national level [14,15].

The BAPCOC has motivated the implementation, under the management of the Scientific Institute of Public Health (WIV-ISP), of a compulsory national surveillance on consumption of systemic antibacterial agents (J01) in all hospitals providing acute healthcare and in large settings dispensing chronic healthcare. Hospitals remain indeed the utmost place wherefrom antimicrobial resistances can arise and scatter [8]. This quantitative survey, able to serve both the local and the national needs for data, is assumed to be part of wider antimicrobial stewardship programmes.

In 2007, a surveillance protocol was finalised at once with a web-based data collection application called NSIHweb; together, they offer hospitals a standardized calculation methodology as well as a centralized recording system. As soon as data are entered in the application, the end-user, an authorized person only, can instantly view the hospital consumption trends (longitudinal analyses) as well as basic national comparative indicators (point analyses). Hospitals data are stored on a secured server at the WIV-ISP and further used to draw national consumption trends over time. In 2010, the surveillance has been extended to other anti-infective agents like systemic antymycotic drugs (J02), although the name of the programme was kept unchanged. In the present document, the acronym BeH-SAC will be used to refer to it, which stands for “Belgian Hospitals - Surveillance of Antimicrobial Consumption”.

We are here presenting some of the results of the surveillance BeH-SAC since it has started in 2007 until the year 2013. A selection of outputs has been carried out under the supervision of the board of the BAPCOC’s working group. Further results and more detailed figures are gathered in a joint document entitled “Appendices to the national Report on Consumption of systemic Antimicrobial Agents in Belgian Hospitals, 2007-2013” which can be downloaded from the NSIH.be webpages (www.wiv-isp.be/nsih).
2. Objectives of the surveillance

The Belgian surveillance BeH-SAC on antimicrobial agents consumption³ (AMC) in hospitals has been set up to fulfil three complementary objectives:

- Provide Belgian hospitals with a standardised methodology of evaluation that takes into account the latest international recommendations with regard to antimicrobial consumption.
- Enable Belgian hospitals, especially those who do not have a dedicated program or service at their disposal, to monitor their own AMCs, to identify any molecules and/or departments that may be problematic, and to follow up related correction actions taken by the AMTs.
- Provide meaningful indicators and reliable figures and trends on hospital antimicrobial agents consumption at national level.

Antimicrobial agents (AM) encompass several classes and subclasses of anti-infective drugs which are best classified according to the WHO international ATC/DDD system⁴. In the ATC/DDD system, each combination associating four components is given a reference drug quantity: the Defined Daily Dose (DDD). Those four components are i/ an organ (or a body site of action), ii/ a product (an active substance or combination of active substances), iii/ an expected physiological effect on a human adult weighting 70 kg, and iv/ a route of administration. These ATC/DDD classification and system are widely used in Europe and around the world. They allow for useful international overviews and trend comparisons. Nevertheless, they are not fully representative of the clinical guidelines and habits of a particular context and only apply to adult patients.

In Belgium, the ATC classification is used as such, without any modification. In addition, a Daily Dose Administrated system (DDA) is also commonly used. The Belgian DDA system has been elaborated to match the local clinical recommendations and practices; besides the four elements incorporated in the ATC/DDD index, it also takes into account the concentration of the drug packages. In this manner, packages intended to paediatric patients are associated with a reduced reference drug quantity and the AMC for such patients can be better estimated. This implies that DDA must be updated according to the evolution of the practices and to the products available on the “market”; the current list of DDA, which is much wider than the ATC/DDD index, needs further validation and could therefore not be used in the present report, to analyse the AMC trends.

³ Despite certain conceptual nuances that could be implied, the wordings “consumption” and “use” are here equally utilized to refer to the drugs that have been removed from the hospital pharmacy stocks, then distributed to hospitalised patients and recorded into the hospital invoicing system.

⁴ ATC/DDD WHO classification: see http://www.whocc.no/atc_ddd_index and following webpages.
3. Methodology

3.1. Concerned institutions and data sources

The participation to the surveillance BeH-SAC is mandatory for all acute healthcare and for large chronic healthcare facilities (which means those having 150 or more beds) because such institutions receive annually public funds to support their AMTs’ actions. Chronic hospitals are all specialised institutions (psychiatry, rehabilitation, geriatrics). Along with this hospital-based quantitative surveillance on AMC carried out independently by the WIV-ISP, AMTs must also submit to the BAPCOC an administrative report about the local strategies and activities they have implemented during the year. Part of the funding provided is hence specifically dedicated to the reporting so as to measure the whole programme’s efficacy. Other types of settings where medical services are provided (long-term care facilities, day-care centres, etc.) might be better evaluated with other methodologies tailored for their types of activities.

Hospitals should preferably deliver their data per site of activity, with as many datasets than there are sites constituting each institution. In such case, the consumption trends can be followed per site, at the very local level, which is supposed to be the optimal monitoring situation. In practice, it happens that some patients are transferred several times for specific cares to other sites of the same institution and that the administrative follow up of those patients is registered under a unique site. This occurs for instance, when a site dedicated to geriatric patients or to rehabilitation activities sends inpatients for some days to acute care departments located in another site of the same merger and then brings them back to their original hospitalisation wards. Accordingly, the surveillance could then be carried out at the level of the administrative entity. In this report, “hospital” stands for “merger”, which is the entity as seen by the federal Administration. According to the BAPCOC’s advice for the elaboration of national trends and results, data of several sites belonging to a same administrative entity have indeed been merged together into one batch. Therefore, the analyses presented here are made at a level that is slightly different than those presented in the NSIHweb application.

Data on consumption (numerator data) are extracted out of the hospital (pharmacy) routine invoicing systems. Hospitals must provide the total number of treatment doses that have been provided to inpatients and that are recorded in the invoicing systems for future reimbursement. The surveillance covers all substances belonging to the following ATC classes: A07A, J01, P01AB, J02, D01BA and J04. These classes correspond to those enclosed in the European Surveillance of Antimicrobial Consumption-Network (ESAC-Net) project, with the exception of antiviral products (J05). Each single prescribed treatment dose falling under the surveyed AM ATC classes must be integrated into the computations, specifying whether it has been given in the adult or paediatric sector. In this report, though, we have reduced the AMC to the two main classes J01 and J02, because the data quality check has shown over consecutive years that other ATC classes were poorly reported by hospitals.

In order to establish a certain level of comparison between hospitals, the consumptions are weighted by some of the hospital’s activity characteristics (denominator data). Aggregated data such as number of admissions and number of patient-days (occupied bed-days) were therefore also supplied by hospitals. The source of these data is the Admission-Discharge-Transfer system, each hospital is equipped with. At the time of setting-up the surveillance, the possibilities of secure, fast and confidential individual data collection were fastidious and data linkage was limited. Thus, patients’ records like the age or the diagnosis were not registered, nor any information related to the prescriber.
3.2. Data collection and data flow

Upon invitation sent by the BAPCOC (data call), hospitals must furnish their data aggregated at least yearly. They can also participate on a monthly basis, which involves that both consumption and activity data should be supplied per month. As mentioned earlier, some participating hospitals provide their data for each individual site of activity, whereas others take part through a single dataset on behalf of a whole merger.

All inpatient wards are included in the surveillance but outpatient activities and consultations such as emergencies and day clinic are excluded. According to the protocol, denominator data related to psychiatric beds are excluded because including them could induce a non-negligible underestimation of the antimicrobial inpatient consumption rate. The argument behind this exclusion criterion is that patients admitted in those beds are usually not affected by any infectious condition and hence seldom need antimicrobial agents, while their hospitalisations are often longer than the somatic patients’ average stays. Constituting a particular inpatient group, their contribution to the denominators might be overwhelming as compared to their share in the numerators. In a practical way, to minimise the workload, the AMC attributed to those patients, which has a limited impact on the total AMC, is included in the data collection whereas their stays must be left out of the denominator data.

The mandatory aspect of the surveillance concerns the AMC in the entire hospital (also identified as hospital-wide or total – TOT – consumption) on the one side and the AMC in the paediatric wards (PED) and in the non-paediatric departments (NPD) on the other side. The consumption at the entire hospital level corresponds to the sum of the consumption in PED and in NPD. The NPD consumption includes all medical, surgical and specialised wards that are not specifically dedicated to paediatric inpatients; this means that the label NPD includes intensive care units (ICU) as well as haematology and/or oncology units (HAO). Because these two last types of units are known to be places with highest AMC, hospitals can also provide, on a voluntary basis, their consumption data collected specifically about their ICUs and/or their HAO. This opportunity to follow high-density areas of AMC has been kept as optional due to the heavy workload it might represent for some institutions.

Figure 3.1. Concept of the BeH-SAC dataflow on NSIHweb application (S. Vaerenbergh, WIV-ISP)
The WIV-ISP is annually editing an updated and comprehensive list of all AM products included in the surveillance, describing their characteristics such as the strength of the active substance per single dose of treatment, its national unique identification code, its labelling, etc. This list, also called “national register”, serves as a frame for the preparation of a template blank file (a spread sheet) that hospitals can then fill in, either manually or using computer programs, depending on the IT maturity of the institution.

Product by product, the number of single doses of treatment that have been dispensed during a specified period of time must be counted up, based on the invoices produced by the hospital. Totals are written down on the spread sheet which can then uploaded on the application NSIHweb, which will copy the batch and add it to the national AMC database hosted on a secured WIV-ISP server (Figure 3.1). This completes the numerator part of the declaration. Hospital activity (denominator) data are entered manually on a dedicated NSIHweb page.

After entering the data, end-users can immediately view their own results online. Once all required data are submitted and upon interactive request (by an authorised person and via a local computer), NSIHweb instantly converts the billing data per product into hospital consumption per ATC code, in terms of DDD weighted for the hospital inpatient activity. Results are displayed using graphs and tables. These automated transformations are called instant feed-backs. Hospitals can get three different types of feed-backs. One establishes a one-time comparison of consumptions for a specific ATC-class or product between the hospital and the national related parameters (means, medians, percentiles). Another feed-back focuses on the hospital’s own results over the time (trends). A third one allows exporting partial datasets on an electronic spread sheet.
3.3. National analyses

Delivered data have first been tested for completeness, stability across the years and reliability (correctness of the totals). During the preliminary analyses, hospitals with outlying results were identified. In case of missing or inconsistent data, hospitals were contacted for revision and indeed, more reliable data were mostly re-uploaded. Only validated data are presented in this report. In small-sized groups, descriptive statistical parameters, including position parameters, can present important true variations.

Based on a BAPCOC’s experts advise, the multidose packages (mainly syrups) have been discarded during the computations, because they are mainly intended to children and induce an important overestimation of the paediatric AMC. Even if only one spoon of syrup is administrated to a young patient, the full bottle, containing often 12, 16 or more doses, is systemically invoiced because a bottle cannot be shared into one single treatment dose.

Unless otherwise specified, the results presented in this report are based on the medians of individual hospitals data. For most antimicrobial agents, the consumption do not follow a normal distribution. Medians are used instead of means, to limit the influence of extreme values. To go further and be consistent, percentiles are preferred to standard deviations. Graphs were generated using STATA (version 10). Boxplots display the median, the inter-quartile range (IQR, delimited by the P25 and P75), upper and lower whiskers (computed as the adjacent values of respectively P75+1.5 IQR and P25-1.5 IQR), as well as outliers (outside dots). Stacked graphs are plotting, for each class or subclass of products, the value of the median hospital in that specific class or subclass. Which means that national stacked graphics are not representing the real consumption in a single hospital that would be the “median hospital” in Belgium, but rather are summing up real figures coming from different hospitals to picture out the median consumption per subclass. A consequence of this computation might be a slight overestimation of the national consumptions and trends as compared to real hospital consumptions. While analysing the consumption variability between hospitals, the test of Kruskal-Wallis for two or more small and/or non-parametric samples with a significance threshold set at $p < 0.05$ has been applied, based on a first visual screening of box-plots indicating a possible variation between groups.
4. Characteristics of participating hospitals

4.1. Participation

In order to match the international usual denomination with the administrative classification of Belgian hospitals (cfr. Federal Public Service Health, Food Chain Safety & Environment, FPS), “general hospitals” are assimilated to primary hospitals, whereas the category “general hospitals with teaching missions” is associated with the secondary level of care; eventually, academic hospitals are identified as being the third level of the healthcare system. Following a request made by the working group “Hospital Medicine”, acute general hospitals, whether they have teaching missions or not, are also grouped, in this report, into a category called “Non-teaching hospitals”, in contrast with the “teaching” or academic hospitals. The academic group is constituted by the seven university hospitals (UZAntwerp, UZGent, KULeuven, ULiège, ULBruxelles, UCLouvain, UZBrussel) plus the site Mont-Godinne and the Institut Bordet in Brussels. The latter is specialised in cancer treatment, has no ward dedicated to paediatric patients and belongs to the group of hospitals with 400 beds or less. The participation according to the Belgian classification of hospital is illustrated in the Table 4.1.

Table 4.1. Hospitals with validated participation to the surveillance of antimicrobial consumption and rate of participation, per level of healthcare settings, Belgium, 2007-2013

<table>
<thead>
<tr>
<th></th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
<th>Expected participation in 2012</th>
<th>Effective participation rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>General Hospitals</td>
<td>35</td>
<td>74</td>
<td>76</td>
<td>75</td>
<td>75</td>
<td>72</td>
<td>64</td>
<td>82</td>
<td>87.8%</td>
</tr>
<tr>
<td>General Hospitals with teaching missions</td>
<td>12</td>
<td>13</td>
<td>13</td>
<td>13</td>
<td>13</td>
<td>12</td>
<td>12</td>
<td>12</td>
<td>92.3%</td>
</tr>
<tr>
<td>Academic Hospitals</td>
<td>8</td>
<td>9</td>
<td>9</td>
<td>9</td>
<td>9</td>
<td>9</td>
<td>9</td>
<td>9</td>
<td>100%</td>
</tr>
<tr>
<td>Chronic</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>6</td>
<td>5</td>
<td>4</td>
<td>1</td>
<td>6</td>
<td>66.7%</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>57</td>
<td>99</td>
<td>101</td>
<td>103</td>
<td>102</td>
<td>97</td>
<td>84</td>
<td>110</td>
<td>88.2%</td>
</tr>
</tbody>
</table>

A participation rate has been computed for the year 2012 based on the FPS administrative list of hospitals and is also presented in Table 4.1. The effective participation rates obtained do not always reach thresholds that could be expected in the framework of a compulsory surveillance. It happened that technical or structural re-organisation (merging, moving, new computer environment, etc.) temporarily hampered some healthcare settings to take part in the surveillance (for one or several months), which invalidated their yearly totals. Other hospitals did not provide any data nor explanations for several consecutive years. In the analysis of the participation rate, it should also be noticed that hospital setups undergo changes, such as merging, which can be administratively registered with a certain delay. Furthermore, changes do occur on a monthly-basis whereas there is a unique mode of participation to the surveillance for each year. We therefore expect that the non-participation is partly due to a slight time gap between the administrative listing and the field reality.

Participants must at least deliver their data split within paediatric (PED) and non-paediatric departments (NPD), as long as such departments do exist in the healthcare setting (e.g.: chronic hospitals only have non-paediatric departments and all wards of paediatric hospitals are registered under paediatrics). Table 4.2 provides a picture of the participation per type of unit. The sum of the AMC use in PED and in NPD corresponds to the consumption in the whole hospital (TOT). The data provision for other specific wards - intensive care units (ICU) and haematology-oncology (HAO) - is not mandatory. The AMC use in those specific wards is included in the NPD consumption.

The data must be aggregated at least on a yearly basis. About one third of all participants provide a higher level of details, with monthly-aggregated data. The national results and trends are computed at the hospital-wide level, mostly for the need of a global overview and for comparisons with other countries. At a local level, where the members of the AMTs have a sound understanding of their setting, specific results per department or ward (PED, NPD, ICU or HAO) are certainly more significant and are thus also provided.
Due to the technical constraints at the moment the NSIHweb application was build, online feedbacks could not be provided taking into account the hospital size. To address this lacking information, we have performed in this national report the analyses according to the hospitals size, in terms of number of beds in the whole hospital (administratively speaking). The participation to the surveillance per category of size is displayed hereunder in Table 4.3. Hospitals having 400 beds or less represent nearly half of all Belgian acute hospitals (48%). Hospitals having from 401 to 800 beds represent a third of all participants and big facilities, with more than 800 beds weight for just a little less than a fifth of participants (19%). Those categories of hospital size based on the number of beds, proposed by the BAPCOC’s experts, are used in other programmes related to healthcare-associated infections. The first institutions who have joined the BeH-SAC and other healthcare improvement programmes implemented by the BAPCOC are mostly big hospitals, with a large bed capacity. Their efforts in the domain are somehow seen as “pioneering”. Smaller institutions have mostly joined the programmes later, when they had more resources to adopt organisational changes. Therefore, the categorisation per hospital size carries an historical approach, which is meaningful to many concerned healthcare practitioners.

Table. 4.2. Acute hospitals with validated participation to the surveillance of antimicrobial consumption, per type of departments, Belgium, 2007-2013

<table>
<thead>
<tr>
<th>Category</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
</tr>
</thead>
<tbody>
<tr>
<td>HOSPITAL-WIDE (TOT)</td>
<td>55</td>
<td>96</td>
<td>98</td>
<td>97</td>
<td>97</td>
<td>93</td>
<td>83</td>
</tr>
<tr>
<td>PAEDIATRICS (PED)</td>
<td>51</td>
<td>89</td>
<td>91</td>
<td>87</td>
<td>88</td>
<td>84</td>
<td>73</td>
</tr>
<tr>
<td>NON-PAEDIATRIC UNITS (NPD)</td>
<td>54</td>
<td>95</td>
<td>97</td>
<td>96</td>
<td>96</td>
<td>92</td>
<td>79</td>
</tr>
<tr>
<td>INTENSIVE CARE UNITS (ICU)</td>
<td>43</td>
<td>65</td>
<td>71</td>
<td>74</td>
<td>71</td>
<td>69</td>
<td>63</td>
</tr>
<tr>
<td>HAEMATO-ONCOLOGY UNITS (HAO)</td>
<td>19</td>
<td>20</td>
<td>24</td>
<td>25</td>
<td>23</td>
<td>22</td>
<td>20</td>
</tr>
</tbody>
</table>

Table. 4.3. Acute hospitals with validated participation to the surveillance of antimicrobial consumption, per category of hospital size, Belgium, 2007-2013

<table>
<thead>
<tr>
<th>Category</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;= 400 beds</td>
<td>19</td>
<td>46</td>
<td>46</td>
<td>45</td>
<td>47</td>
<td>43</td>
<td>37</td>
</tr>
<tr>
<td>401 - 800 beds</td>
<td>21</td>
<td>31</td>
<td>33</td>
<td>33</td>
<td>32</td>
<td>32</td>
<td>29</td>
</tr>
<tr>
<td>&gt; 800 beds</td>
<td>15</td>
<td>19</td>
<td>19</td>
<td>19</td>
<td>18</td>
<td>18</td>
<td>17</td>
</tr>
<tr>
<td>TOTAL</td>
<td>55</td>
<td>96</td>
<td>98</td>
<td>97</td>
<td>97</td>
<td>93</td>
<td>83</td>
</tr>
</tbody>
</table>
4.2. Length of stay in acute healthcare settings

The hospital-wide average length of stay (LoS) in acute settings is slowly but regularly decreasing between 2007 and 2013, with an average yearly rate of -1.1% (-6.8% over the whole period). For detailed figures on LoS, see the part A of the Appendices. More specifically, the decrease reaches 11.4% in non-paediatric departments (NPD) when all acute hospitals are grouped together. To go further, the decrease is more pronounced in NPD of general (primary) hospitals and of small settings (400 beds or less), with a similar rate of -13.6% over the seven years. When looking at the evolution of LoS in paediatrics (PED), very different patterns are visible, depending on the categorisation used. PED in primary and small-sized hospitals show a decrease (-13.5% and 18.9% respectively); on the contrary, PED of tertiary and large-sized settings show an increase (4.9% and 8.3%). PED of mid-sized hospitals (401-800 beds) display a 10.5% reduction of the LoS between 2007 and 2013. Surprisingly, secondary hospitals, which involves about 12 PED services, present a remarkable change from four days in 2007 to six days in 2013. Although the trend is also seen (in a lesser extent, though) when means are used instead of medians, conclusions on small clusters must be drawn with much cautiousness.

For this reason, the evolutions of the average LoS in specialised departments such as intensive care units (ICU) and haematology and/or oncology (HAO) should be analysed globally (all hospitals together). Under this conditions, it can be mentioned that LoS in ICU show a very slight increase (less than 5% over all the years) while the LoS in HAO is more stable around a value of 10 days.

![Figure 4.1. Evolution of the median length of stay (in days) in acute hospitals, per type of department, Belgium, 2007-2013](image-url)

Figure 4.1. Evolution of the median length of stay (in days) in acute hospitals, per type of department, Belgium, 2007-2013

Looking at the hospital as a whole, at paediatrics or at non-paediatrics, one can observe that patient’s stays in Belgian acute hospitals are shortening (Figure 4.1). When the investigation is brought in terms of category of hospitals, though, conclusions are more nuanced. Depending on the grouping and on the types of department or unit that are looked at, the median LoS can evolve along the time with significantly divergent trends. As a matter of consequence, it will be important, while examining the AMC in Belgian hospitals, to take into account both calculations in terms of DDD / 1000 patient-days and of DDD / 1000 admissions in order to obtain a more thorough and balanced understanding of the phenomenon.
5. Overview of the antimicrobial consumption (hospital-wide, J01 & J02)

5.1. Overall consumption in acute healthcare settings

According to the data collected by BeH-SAC, the year 2013 shows a decrease in the antibacterial agents (J01) use as compared to the previous year (Fig. 5.1). This decrease is covering the total (TOT) antibacterial consumption (ABC), meaning all paediatric (PED) and non-paediatric departments (NPD) combined together and can be seen both in terms of daily consumption (~3.1%) and in terms of consumption over a stay (~8.4%) (Table 5.1). This constitutes encouraging news, because the ABCC was previously slowly but quite regularly increasing with an average yearly rate of 1.6%, passing from 520 in 2007 to 560 DDD / 1000 patient-days in 2012. The increase looks smaller when the analysis is done using the indicator DDD / 1000 admissions (showing a total growth of 4.1% over 5 years). This discrepancy, related to which indicator is chosen, can be explained by the reduction of the average hospital length of stay (LoS).

![Antibiotic (J01) use in Belgian acute hospitals](image)

Figure 5.1. Trends and distribution of antibacterial agents (J01) consumption in all acute hospitals, hospital-wide, expressed in DDD / 1000 patient-days and in DDD / 1000 admissions, Belgium, 2007-2013

<table>
<thead>
<tr>
<th>Table 5.1. Distribution of antibacterial (J01) and of systemic antimycotic (J02) consumption agents in all acute hospitals, hospital-wide, expressed in DDD / 1000 patient-days and in DDD / 1000 admissions, Belgium, 2007-2013</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Antimicrobial agents (J01 &amp; J02) hospital-wide consumption in acute hospitals</strong></td>
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<tr>
<td><strong>DDD / 1000 patient-days</strong></td>
</tr>
<tr>
<td><strong>J01</strong></td>
</tr>
<tr>
<td>Frequency</td>
</tr>
<tr>
<td>Mean</td>
</tr>
<tr>
<td>P25</td>
</tr>
<tr>
<td>Median</td>
</tr>
<tr>
<td>P75</td>
</tr>
<tr>
<td><strong>J02</strong></td>
</tr>
<tr>
<td>Frequency</td>
</tr>
<tr>
<td>Mean</td>
</tr>
<tr>
<td>P25</td>
</tr>
<tr>
<td>Median</td>
</tr>
<tr>
<td>P75</td>
</tr>
</tbody>
</table>
As far as systemic antimycotic agents (J02) are concerned, no clear trends can be identified, as the median consumption of this ATC-subclass fluctuates within a margin of about 25% around 22 DDD / 1000 patient-days and 167 DDD / 1000 admissions. The inter-hospitals variability of the antimycotic agents consumption is large and not clearly decreasing as years are passing (Table 5.1 and Fig. 5.2).

Figure 5.2. Trends and distribution of systemic antimycotic agents (J02) consumption in all acute hospitals, hospital-wide, expressed in DDD / 1000 patient-days and in DDD / 1000 admissions, Belgium, 2007-2013

To verify whether these encouraging results observed in 2013 were based on a true reduction of the ABC or were a statistical artefact due to a smaller number of participant for that year, the same analysis has been done on a reduced sample of hospitals who have consistently provided their AMC data since 20085. The results of this smaller sampling are shown in Table 5.2 and in Fig. 5.3. and confirm the observations made at the wider level.

Table 5.2. Distribution of antibacterial agents (J01) and of systemic antimycotic agents (J02) consumption in acute hospitals participating consistently since 2008, hospital-wide, expressed in DDD / 1000 patient-days and in DDD / 1000 admissions, Belgium, 2008-2013

<table>
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<tr>
<td><strong>J01</strong></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Frequency</td>
<td>78</td>
<td>78</td>
<td>78</td>
<td>78</td>
<td>78</td>
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<td>78</td>
<td>77</td>
<td>77</td>
<td>78</td>
<td>77</td>
<td>77</td>
</tr>
<tr>
<td>Mean</td>
<td>537.5</td>
<td>547.7</td>
<td>543.6</td>
<td>550.5</td>
<td>567.4</td>
<td>539.5</td>
<td>3953</td>
<td>3978</td>
<td>3919</td>
<td>3966</td>
<td>3965</td>
<td>3674</td>
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<tr>
<td>P25</td>
<td>461.1</td>
<td>477.0</td>
<td>478.9</td>
<td>484.2</td>
<td>495.8</td>
<td>479.5</td>
<td>3391</td>
<td>3463</td>
<td>3536</td>
<td>3502</td>
<td>3385</td>
<td>3206</td>
</tr>
<tr>
<td>Median</td>
<td>524.4</td>
<td>549.2</td>
<td>543.8</td>
<td>554.1</td>
<td>559.3</td>
<td>544.9</td>
<td>3754</td>
<td>3849</td>
<td>3867</td>
<td>3784</td>
<td>3876</td>
<td>3602</td>
</tr>
<tr>
<td>P75</td>
<td>590.6</td>
<td>603.7</td>
<td>605.1</td>
<td>617.4</td>
<td>626.1</td>
<td>603.0</td>
<td>4502</td>
<td>4490</td>
<td>4274</td>
<td>4359</td>
<td>4415</td>
<td>4252</td>
</tr>
<tr>
<td><strong>J02</strong></td>
<td></td>
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<td></td>
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<tr>
<td>Frequency</td>
<td>68</td>
<td>68</td>
<td>68</td>
<td>68</td>
<td>68</td>
<td>68</td>
<td>68</td>
<td>67</td>
<td>67</td>
<td>68</td>
<td>67</td>
<td>67</td>
</tr>
<tr>
<td>Mean</td>
<td>31.1</td>
<td>27.8</td>
<td>29.5</td>
<td>32.3</td>
<td>33.0</td>
<td>31.4</td>
<td>230</td>
<td>202</td>
<td>212</td>
<td>230</td>
<td>229</td>
<td>208</td>
</tr>
<tr>
<td>P25</td>
<td>14.4</td>
<td>11.8</td>
<td>12.9</td>
<td>15.1</td>
<td>15.0</td>
<td>13.8</td>
<td>106</td>
<td>86</td>
<td>90</td>
<td>102</td>
<td>109</td>
<td>97</td>
</tr>
<tr>
<td>Median</td>
<td>24.3</td>
<td>20.9</td>
<td>21.9</td>
<td>25.8</td>
<td>23.1</td>
<td>22.6</td>
<td>171</td>
<td>167</td>
<td>176</td>
<td>178</td>
<td>179</td>
<td>164</td>
</tr>
<tr>
<td>P75</td>
<td>37.9</td>
<td>34.1</td>
<td>36.3</td>
<td>37.1</td>
<td>39.0</td>
<td>32.5</td>
<td>264</td>
<td>252</td>
<td>273</td>
<td>268</td>
<td>282</td>
<td>21</td>
</tr>
</tbody>
</table>

5 The year 2007 was discarded because at the start of the surveillance, not all hospitals were able to provide (good quality) data.
Figure 5.3. Trends and distribution of antibacterial agents (J01) consumption in acute hospitals participating consistently since 2008, hospital-wide, expressed in DDD / 1000 patient-days and in DDD / 1000 admissions, Belgium, 2008-2013

Stacked graphs, as those presented in the Figure 5.4, enable an easy visualisation of the part that different ATC-subclasses take amongst the yearly total AMC. Penicillins combined with an enzyme inhibitor (J01CR) were already known to be the most used group of AB. They are followed by the fluoroquinolones (FQ, J01MA) and the 1st-generation cephalosporins (1GC). The generic subclass called “Other antibacterials” (J01X) comes behind and includes products having very different application. This group of AB will hence been carefully looked at later in this report.

Figure 5.4. Distribution per ATC-subclasses of antimicrobial agents (J01 & J02) consumption in acute hospitals, hospital-wide, expressed in DDD / 1000 patient-days and in DDD / 1000 admissions, Belgium, 2007-2013
Nevertheless, following the evolution across the time of each of those ATC-subclasses on stacked graphs presents some difficulties. The Figure 5.5 better address the examination of time trends within each ATC-subclass. The latter clearly shows that the overall AMC drop observed in 2013 is mainly caused by the fall of consumption in the J01CR family, meaning the combinations of penicillins with an enzyme inhibitor (J01CR). The AMC drop is further reinforced by a smaller use of fluoroquinolones (J01MA) for the year 2013. In terms of daily treatment, the ATC-subclasses that have been more used across the time are, after the J01CR until 2012, the penicillins with extended spectrum (J01CA), the 3CG (J01DD) and 1CG (J01DB). An increase is also visible for the carbapenems (J01DH). The aminoglycosides (J01G) constitute the only group where a regular and constant decreased can be noticed.

![Antimicrobial agents consumption trends in acute hospitals](image)

Figure 5.5. Time trends, per ATC-subclasses, of antimicrobial agents (J01 & J02) consumption in acute hospitals, hospital-wide, expressed in DDD / 1000 patient-days and in DDD / 1000 admissions, Belgium, 2007-2013
5.2. Overall consumption in chronic hospitals

To our knowledge, only six chronic hospitals are subjected to a participation to BeH-SAC. Due to their very different goals, patterns and populations, chronic hospitals cannot be compared with acute healthcare settings; in this national report, they are hence set and analysed apart.

![Antibacterial agents (J01) consumption in Belgian chronic hospitals](image.png)

**Figure 5.6.** Time trends of antibacterial agents (J01) consumption in chronic hospitals, hospital-wide, expressed in DDD / 1000 patient-days, Belgium, 2007-2013

Only one chronic hospital has provided AMC data for all the seven years of the surveillance. In that hospitals, the consumption both for J01 and J02 are evolving toward a reduction. Two hospitals have participated for four years and the three others for only three years (Fig. 5.6). The AMC in chronic healthcare settings must be interpreted independently from each other, at the hospital-level.

If any conclusion can be drawn at the national level, much caution must be taken, because of the small number of participants. Yearly results obtained from less than three participants have a low representativeness and thus reliability. The rough picture of the AMC in those long-term care settings gives nevertheless the idea that it is regularly declining from 2007 to 2012 (see Fig. 5.7).
Figure 5.7. Distribution per ATC-subclasses of antimicrobial agents (J01 & J02) consumption in chronic hospitals, hospital-wide, expressed in DDD / 1000 patient-days and in DDD / 1000 admissions, Belgium, 2007-2012

Note: Year (National median length of stay). Y axis: Stacked bars are made by summing the median hospital consumption for each ATC-class
013: only one chronic hospital has participated, results not shown. Source: WIV-ISP. Surveillance of antimicrobial agents use in Belgian hospitals.
6. Antimicrobial consumption in acute hospitals, per speciality

6.1. Antimicrobial consumption in acute non-paediatric departments

The daily consumption of all antibiotic agents (J01) in non-paediatric departments of all acute hospitals was slightly but regularly increasing between 2007 and 2012. The year 2013 shows a stabilisation around 550 DDD / 1000 patient-days. Between 2007 and 2012, respectively more than 94% and about 96% of the J01 and J02 hospital-wide use occur in non-paediatric departments. For the year 2013, these ratios were reduced to respectively 90% and 93%.

When categorized per size, “small” (hospitals with 400 beds or less), “medium” (hospitals having from 401 to 800 beds) and “large” (hospitals with more than 800 beds), non-paediatric departments of acute healthcare settings present an uneven pattern of antibiotic agents (J01) consumption (see Fig. 6.1 and Appendices, Tables E5 & E6). Whether the analysis of the global ABC is done per patient-days or per admissions, the size – measured in terms of number of beds – does not seem to be a marker of difference between acute hospitals. The levels and trends of consumption are close, there is no particular patterns to be observed. This categorisation is therefore, in this case, of little interest.

![Graph showing trends and distribution of antibiotic agents (J01) consumption in acute hospitals, per hospital size, non-paediatric departments, expressed in DDD / 1000 patient-days and in DDD / 1000 admissions, Belgium, 2007-2013](image)

On the contrary, the categorisation per level of healthcare shows more regular trends (Fig. 6.2). A 15% increase in the J01 use per patient-days is clearly seen until 2012 in the primary healthcare settings but the use per admissions appears to be quite stable around 4000 DDD / 1000 admissions (see Appendices, Tables E3 & E4). In general hospitals with teaching missions, or secondary healthcare settings, the trend in terms of DDD / 1000 patient-days was decreasing until 2013, when the ABC got higher than in 2012. Still in secondary settings, the global ABC per admissions has regularly shrunk of 17% between 2007 and 2013, included.

There are only nine tertiary or teaching hospitals in Belgium; their ABC distributional parameters are thus prone to important variability around almost 700 DDD / 1000 patient-days and over 5000 DDD / 1000 admissions. This allows to pinpoint the fact that the level of ABC in those highly specialized healthcare settings is significantly higher than in
non-teaching hospitals, both in terms of consumption per day (≈27%) and per stay (≈20%). The same observations can be made for the J02 consumption (see Fig. 6.3).

Figure 6.2. Trends and distribution of antibacterial agents (J01) consumption in acute hospitals, per level of healthcare, non-paediatric departments, expressed in DDD / 1000 patient-days and in DDD / 1000 admissions, Belgium, 2007-2013

Figure 6.3. Trends and distribution of antymycotic agents (J02) consumption in acute hospitals, per academic status, non-paediatric departments, expressed in DDD / 1000 patient-days and in DDD / 1000 admissions, Belgium, 2007-2013

More precisely and as shown in the Figure 6.4 hereafter, a large part of the dissimilarity between non-teaching and teaching hospitals leans on some specific products; namely, the β-lactamase resistant penicillins (J01CF, ratio 1:3),
the 4GC (J01DE, ratio 1:8), the carbapenems (J01DH, ratio 3:8), the vancomycin (J01XA01, ratio 1:4), colistin (J01XB01, ratio 1:2) and the antimycotic agents (J02, ratio 1:4). The case-mix observed in those academic highly-equipped facilities partially justifies different therapeutic needs and AMC consumption practices. In spite of this rationale, further inquiries should be carried out on this disparity, at the national level as well as at the hospital level by AMT’s, taking as much as possible into account the diagnosis that was made and the patient’s conditions.

The Figure 6.5 indicated that if primary and secondary hospitals have, in patient-days, quite close consumption patterns, they noteworthy differ in terms of use per admissions. Secondary hospital clearly display decreasing AMCs due mainly to a reduced use of combinations of penicillins with enzyme inhibitor (J01CR), of FQ (J01MA) and of penicillins with extended spectrum (J01CA). The evolutions of the AMC per ATC-subclass and per healthcare level are presented in Figures 6.6, 6.7 and 6.8. Among primary acute hospitals, a lessening of use seems to be visible only in the group of aminoglycosides (J01G).
Figure 6.5. Distribution per ATC-subclasses of antimicrobial agents (J01 & J02) consumption in acute hospitals, per level of healthcare, non-paediatric departments, expressed in DDD / 1000 patient-days and in DDD / 1000 admissions, Belgium, 2007-2013.

Figure 6.6. Time trends, per ATC-subclasses, of antimicrobial agents (J01 & J02) consumption in acute primary hospitals, non-paediatric departments, expressed in DDD / 1000 patient-days and in DDD / 1000 admissions, Belgium, 2007-2013.
Figure 6.7. Time trends, per ATC-subclasses, of antimicrobial agents (J01 & J02) consumption in acute secondary hospitals, non-paediatric departments, expressed in DDD / 1000 patient-days and in DDD / 1000 admissions, Belgium, 2007-2013.

Note: National median consumption. Source: WIV-ISP. Surveillance of antimicrobial agents in Belgian hospitals.

Figure 6.8. Time trends, per ATC-subclasses, of antimicrobial agents (J01 & J02) consumption in acute tertiary hospitals, non-paediatric departments, expressed in DDD / 1000 patient-days and in DDD / 1000 admissions, Belgium, 2007-2013.

Acute tertiary hospitals only. Participation: 2007 n=8; 2008 n=9; 2009 n=9; 2010 n=9; 2011 n=9; 2012 n=9; 2013 n=9.
Note: National median consumption. Source: WIV-ISP. Surveillance of antimicrobial agents in Belgian hospitals.
Regarding the secondary level of healthcare, many ATC-subclasses show a fall of consumption, as suggested by the regular decline on Figure 6.5. The consumption of some specific products did increase during the first years of the surveillance (see for instance the J01X or J02), but the two or three last years mostly show a stabilisation. Among tertiary hospitals, figures are there again more prone to statistical variability, but raised consumptions can be identified for the resistant penicillins (J01CF) or the 2GC (J01DC) and clear reductions take shape for instance for 1GC (J01DB), 4GC (J01DE) or for quinolones (J01M).

It appears from the overall analyses of the BeH-SAC, that depending on the denominator and the stratification used, the conclusions on the AMC can vary, reflecting an intricate situation. It is important to underline that the calculations are based on all the non-psychiatric hospital stays, including those during which no AM drugs have been prescribed. It would be interesting to perform restrictive computations on hospital stays during which patients have actually been treated with antimicrobial agents, in order to get more precise outcomes. Depending on the evolution of a campus (site) specialisation, the number of hospital stays that do not require any antimicrobial treatment might for instance increase along the years. In such case, an indicator like the number of DDD / 1000 treated admissions would provide a sturdier picture of the antimicrobial stewardship practices in the campus. Although hospitals have the possibility to submit the number of treated admissions in their settings in the NSIHweb application, very few provide them and a national analysis with respect to this aspect does not worth considering. We also have to acknowledge that the web-based application that is currently online can collect this type of data, but the feedbacks provided online do not perform any computation based on them, which by consequence discourage hospitals to further provide this information.
6.2. Antimicrobial consumption in intensive care units

Intensive care units and the highly-specialised haematology and oncology wards are identified as being places involving sensitive, last-line molecules and broad AMC. The possibility has hence be given to hospitals to survey, on a voluntary basis, their AM use in these specific wards via NSIHweb. Not all healthcare settings did provide their data; results shown hereunder have therefore a lesser level of representativeness and are subjects to greater statistical variations, due to smaller sample sizes.

In our database, eight to nine per cent of the antibiotic (J01) non-paediatric use occur in intensive care units (ICU), while haematology and oncology units (HAO) are responsible for about three to five per cent of the ABC in non-paediatrics. As regard to antimycotic agents (J02), HAO units have a greater consumption of J02, with a 22 to 30% share, depending on the years; ICU are accountable for 18 to 22% of the J02 use in NPD. The AMC in HAO is presented in next section.

The Figure 6.9 exposes a five to six-fold higher antimicrobial agents use per stay in ICUs of tertiary as compared to the use in primary hospitals. Alone, the LoS does not justify such a contrast and of course, the type and severity of the cases taken in charge in those two types of settings are assumed to be the main factors explaining this important difference. Further case-based investigations on the quality of the treatment could nonetheless be enlightening.

![Antimicrobial agents (J01 & J02) use in Belgian hospitals in acute healthcare hospitals (intensive care units)](image)

The ICU results for the year 2008 in teaching hospitals look to present outstanding values, but it is not the case. The little number of hospitals participating in that category implies that the median could move much along a widely spread distribution (see Appendices, Tables F3 & F4). After verification, no outlier has been identified in the dataset and no data has thus been discarded; interpretations must take these statistical limitations into account.

The analyse, per hospital size, of the AMC in ICUs shows that “large” hospitals have massively increased the total amount of AM given during a stay, although the LoS did not vary much (Fig 6.10). But precautions due to statistical variations, as highlighted here above, should be applied here again. The results for ICUs of large acute hospitals show
indeed very different patterns of consumption depending on the indicator used for the evaluation: the consumption per patient-day varies around levels similar than those found in the other types of hospitals. But the figures computed per stay show a higher and increasing AM use in large hospitals between 2007 and 2013 in those large healthcare settings, which is worth a closer examination.

One can observe an overall decrease in the average AM patient-day use in “small” hospitals (with 400 beds or less), while their LoS is being almost constant; in particular, the use of J01CR is decreasing. The same type of analysis in medium-sized hospitals seems to show a relative variation of the AMC, with a median around 1200 DDD / 1000 patient-days; for both these categories of hospital size, the AM use per stay varies from year to year but indicates a quite stable level of consumption (see Fig. 6.9). As mentioned just before, large hospitals, which are partly constituted by secondary and partly with tertiary hospitals, present an important expansion of the AM consumption, mainly based on β-lactamase resistant penicillins (J01CF), the 3GC (J01DD), the other antibiotics group (J01X) and the antimycotic agents (J02). Less than ten hospitals are using amphenicols (J01BA), in amounts that differ widely.

The evolution of the AMC per ATC-subclasses in ICUs of non-teaching and of teaching hospitals are displayed in Figures 6.11 and 6.12. In non-teaching institutions, the ICU consumption of the large-spectrum penicillins combined with an enzyme inhibitor (J01CR) is dominating all other ATC-subclasses of drugs. The carbapenems (J01DH) are the second most used group of antibiotics. The use of FQ (J01MA) and of β-lactamase resistant penicillins (J01CF) is increasing both in terms of patient-days and in terms of stay. Fourth-generation cephalosporins (J01DE) are being switched with 3GC (J01DD).
Figure 6.11. Time trends, per ATC-subclasses, of antimicrobial agents (J01 & J02) consumption in acute non-teaching hospitals, intensive care units, expressed in DDD/1000 patient-days and in DDD/1000 admissions, Belgium, 2007-2013

In teaching hospitals, trends are less clearly depicted: several ATC groups, like the antimycotic agents (J02), the 3GC (J01DD) or the heterogeneous group called “other antibiotics” (J01X) display an augmented use in patient-days but a diminished consumption per stay. According to both indicators, however, the 4GC (J01DE) are less and less used.

Figure 6.12. Time trends, per ATC-subclasses, of antimicrobial agents (J01 & J02) consumption in acute teaching hospitals, intensive care units, expressed in DDD/1000 patient-days and in DDD/1000 admissions, Belgium, 2007-2013
6.3. Antimicrobial consumption in haematology and oncology units

With no surprise to clinicians, antimycotic agents (J02) are the most used ATC-subclass in haematology and oncology units (HAO). In non-teaching hospitals, about a quarter of the AMC (J01 & J02) used in HAO is due to systemic antifungal drugs (J02), of which 80% is fluconazole (J02AC01). In HAO units of teaching hospitals, these proportions are respectively a third of the AMC, of which about two third rely on fluconazole. Those are approximate figures, because they do not take additional antimicrobial agents under surveillance such as the antiprotozoals (P01AB) and the antimycobacterial drugs (J04) into account for the total AMC.

Figure 6.13. Distribution per ATC-subclasses of antimicrobial agents (J01 & J02) consumption in acute hospitals, per academic status, haemat- & oncology, expressed in DDD / 1000 patient-days and in DDD / 1000 admissions, Belgium, 2007-2013

Expressed in DDD / 1000 admissions, a decreasing trend of AMC is visible in HAO units of acute non-teaching hospitals. In teaching hospitals and using the same unit, it seems on the contrary that HAO are using more antimicrobial agents in recent years (Figure 6.13). The analysis per level of healthcare allows to specify that the manifest reduction of AM use is due to primary healthcare settings. Secondary healthcare settings have indeed a consumption pattern showing a rise of consumption, just like tertiary hospitals (Figure 6.14). The variations observed do not always coincide with the variations of LoS.

Referring to the categories of hospital size which are requested by the BAPCOC working group, conclusions are there also easier drawn based on the consumption in DDD / 1000 admissions (see Figure 6.15). Medium-sized hospitals, having from 401 to 800 beds, are those where the AMC has shrunk. The group of “small” hospitals presents an important increase during the three first years of the surveillance, followed during the four next years by a dramatic fall. A hypothesis that could explain this evolution is that this might be the reflection of a tendency towards the specialisation of Belgian hospitals. In the course of reorganisations, that regularly occur among Belgian hospitals, “small” institutions who, before 2010, were using more and more AM drugs in their HAO might have handed over those units to other bigger healthcare settings. If this supposition is confirmed, one could further assume, based on the impressive drop of the AMC, that HAO units remaining in hospitals with 400 beds or less are performing well in terms of antimicrobial stewardship.
Looking at the volume of drugs employed, the J02 subclass is followed by the combinations of penicillins and enzyme inhibitors (J01CR). According to both our indicators along the time, the use of that latter group is decreasing in non-teaching hospitals but increasing in teaching ones. The carbapenems (J01DH) look to be more and more prescribed in HAOs of non-teaching institutions, although not reaching the levels used in academic hospitals, where their use...
present a V-shape pattern. Those results are visible in the Figures 6.16 and 6.17 hereafter. Here again, all indicators and all settings seem to indicate that 4GC (J01DE) are spared.

Figure 6.16. Time trends, per ATC-subclasses, of antimicrobial agents (J01 & J02) consumption in acute non-teaching hospitals, haematology & oncology, expressed in DDD / 1000 patient-days and in DDD / 1000 admissions, Belgium, 2007-2013

Figure 6.17. Time trends, per ATC-subclasses, of antimicrobial agents (J01 & J02) consumption in acute teaching hospitals, haematology & oncology, expressed in DDD / 1000 patient-days and in DDD / 1000 admissions, Belgium, 2007-2013
6.4. Antimicrobial consumption in paediatrics

Following a recommendation made by the BAPCOC working group “Hospital Medicine”, products distributed as syrups have been inventoried and removed from the paediatric dataset only, where this type of formulation is mainly used, because full bottles are systematically billed to patients instead of single doses of treatment, regardless of the regimen actually prescribed. This discard is impacting the evaluation of the AMC consumption in paediatrics, in the sense of a slight underestimation rather than a prior possible gross overestimation.

The recommendations of the BAPCOC’s working group were also not to use the DDD as measurement unit, because DDDs are actually defined based on a 70-kg adult physiology and needs. We have accordingly computed the consumption in mg of product and have converted the systemic colistin into its equivalent in mg [16]. Then the quantity in mg have been weighted by the denominator data, as for the previous computations. In this situation, however, the methodology forbids to sum quantities of a product given through different ways of administration, nor can be summed amounts used for different products, even if they belong to the same ATC-subclass. Results of the 15 most used products are presented in Figures 6.18 to 6.21, based on the academic status and for enteral and parenteral products separately.

Products belonging to the group of penicillins (J01C) should be the most represented drugs. As regard to the parenteral route of administration, cephalosporins are also expected to be widely represented.

The surveillance BeH-SAC can only be used to identify which antimicrobial agent or group of agents should be present. The monitoring of AMC in paediatrics is probably more useful at local level, where AMTs know their settings and can interpret fluctuations. This is true as long as the data follow the same methodology, from year to year (no different interpretations affecting the data collection, depending on the person who gather the data). It is not clear whether all hospitals encode their neonatology units into paediatrics or in ICU. This point is an additional factor of uncontrolled variability. Monitoring the AMC in paediatrics would benefit from the availability of both DDA and additional information on the patient’s class of age, allowing for more useful results.

The implementation of antimicrobial stewardship programmes especially intended to neonatology and paediatric patients could be a relevant strategy to fight the problem of antimicrobial resistance in a niche that is often regarded as ancillary or even negligible. Basic principles that could sustain such a strategy are promoted by the European Society for Paediatric Infectious Diseases [17]
Figure 6.18. Time trends consumption of the 15-most used enteral antimicrobial agents (J01 & J02), in acute non-teaching hospitals, paediatrics, expressed in mg / 1000 patient-days and in mg / 1000 admissions, Belgium, 2007-2013

Figure 6.19. Time trends consumption of the 15-most used parenteral antimicrobial agents (J01 & J02), in acute non-teaching hospitals, paediatrics, expressed in mg / 1000 patient-days and in mg / 1000 admissions, Belgium, 2007-2013
In paediatrics as in non-paediatric wards, the most used product is the combination of amoxicillin and enzyme inhibitor (J01CR02), but in a lower proportion, that turns around 25%. Therefore, the ratio sensitive penicillins over combinations of penicillins with enzyme inhibitors (J01CA/J01CR) is having a better achievement in terms of antimicrobial stewardship. The overall trends of consumption in paediatrics are mostly influenced by few products: while the amoxicillin, in association with the clavulanic acid or not, are less used in recent years, ampicillin, mostly injectable, is on the rise.
7. Insight into the antimicrobial consumption

7.1. Most used products, in non-paediatric departments

In the previous part of this report, the overview has been presented based on groups of antimicrobial agents, according to the ATC classification. But certain products carry their own intrinsic interest. This section is hence aiming at describing the consumption patterns of some of those important products.

The most used molecules in acute healthcare settings are presented in the Figure 7.1 and 7.2, based on their academic status. The outstanding consumption of the combination amoxicillin and clavulanic acid (J01CR02), as compared to all other products, somehow squeezes most of the bars at the bottom of the charts, making the reading less comfortable. One can globally notice that in teaching as in non-teaching institutions, the most used drugs are also more and more used on a daily basis, few exceptions set apart.

In non-teaching hospitals, those exceptions concern amoxicillin (J01CA04) and cefuroxim (J01DC02), a 2GC. The temocillin (J01CA17) used against Gram-negative multi-drug resistant organisms (MDRO) and meropenem (J01DH02), active against both Gram-positive and Gram-negative MDRO are both on the raise. Cipro- and moxifloxacin, the two most used fluoroquinolones (J01MA) in non-teaching hospitals are likewise more and more used along the years.

In teaching hospitals, flucloxacillin (J01CF05) as well as the combination of piperacillin and tazobactam (J01CR05) are the two most used products after J01CR02; both show a massive growth of consumption between 2007 and 2013. Vancomycin (J01XA01), meropenem (J01DH02) and moxifloxacin (J01MA14) display also a noticeable increase, while cefepime (J01DE01, a 4GC) and cefazolin (J01DB04) have undergone an important reduction of use over the same period of time.

Figure 7.1. Time trends of the 15 most used antimicrobial agents (J01 & J02) in acute non-teaching hospitals, non-paediatric departments, expressed in DDD / 1000 patient-days and in DDD / 1000 admissions, Belgium, 2007-2013

In non-teaching hospitals, those exceptions concern amoxicillin (J01CA04) and cefuroxim (J01DC02), a 2GC. The temocillin (J01CA17) used against Gram-negative multi-drug resistant organisms (MDRO) and meropenem (J01DH02), active against both Gram-positive and Gram-negative MDRO are both on the raise. Cipro- and moxifloxacin, the two most used fluoroquinolones (J01MA) in non-teaching hospitals are likewise more and more used along the years.

In teaching hospitals, flucloxacillin (J01CF05) as well as the combination of piperacillin and tazobactam (J01CR05) are the two most used products after J01CR02; both show a massive growth of consumption between 2007 and 2013. Vancomycin (J01XA01), meropenem (J01DH02) and moxifloxacin (J01MA14) display also a noticeable increase, while cefepime (J01DE01, a 4GC) and cefazolin (J01DB04) have undergone an important reduction of use over the same period of time.
Figure 7.2. Time trends of the 15 most used antimicrobial agents (J01 & J02) in teaching hospitals, non-paediatric departments, expressed in DDD / 1000 patient-days and in DDD / 1000 admissions, Belgium, 2007-2013

Fluconazole (J02AC01), a large-spectrum systemic antifungal, is ranking n°6 and n°4 of the most used products in respectively non-teaching and teaching hospitals. Moreover, in this latter type of healthcare settings, another antifungal agent is also ranking n°13 despite its recognized side-effects and toxicity: the amphotericin B, used in serious systemic fungal infections. Both molecules, show in both types of settings a V-shape consumption pattern.
7.2. Most used products, in intensive care units and in haematology and oncology units

Remarkably, meropenem is the second and the third most used product in ICUs of respectively non-teaching and teaching hospitals, whereas vancomycin occupies the 13th and 7th position, respectively. In ICUs of academic institutions, colistin, another last-resort MDRO-active drug can be found among the top 10 most used products. Here again, the variability due to a small population is important. It seems however that in these highly-specialized wards, the most commonly administrated products are also more intensively used along the years, which might indicate that the bacterial selective pressure is evolving toward a convergence on few key molecules.

Figure 7.3. Time trends of the 15 most used antimicrobial agents (J01 & J02) in acute non-teaching hospitals, intensive care units, expressed in DDD / 1000 patient-days and in DDD / 1000 admissions, Belgium, 2007-2013

Teaching hospitals only. Participation: 2007 n=7; 2008 n=7; 2009 n=8; 2010 n=8; 2011 n=8; 2012 n=8; 2013 n=8.
Note: National median consumption. Source: WIV-ISP. Surveillance of antimicrobial agents in Belgian hospitals

Figure 7.4. Time trends of the 15 most used antimicrobial agents (J01 & J02) in teaching hospitals, intensive care units, expressed in DDD / 1000 patient-days and in DDD / 1000 admissions, Belgium, 2007-2013
The important year-to-year variability of the AMC use in HAO is likely to limit the drawing of clear and specific conclusions on this domain. Nevertheless, the ranking of the most used products in HAO and their level of consumption is likely to give a reliable picture of local practices. Meropenem (J01DH02) and the combination piperacillin and enzyme inhibitor (J01CR05) are for instance more and more used, whatever the academic status the hospital has (see Fig. 7.5 & 7.6).

Figure 7.5. Time trends of the 15 most used antimicrobial agents (J01 & J02) in acute non-teaching hospitals, haemato- & oncology units, expressed in DDD / 1000 patient-days and in DDD / 1000 admissions, Belgium, 2007-2013

Figure 7.6. Time trends of the 15 most used antimicrobial agents (J01 & J02) in teaching hospitals, haemato- & oncology units, expressed in DDD / 1000 patient-days and in DDD / 1000 admissions, Belgium, 2007-2013
7.3. Variability of consumption, for selected products

7.3.1. Ampicillin and amoxicillin (J01CA01 & J01CA04)

Studying the variability of the antimicrobial consumption is a way to identify contexts where certain products are used with a large panel of practices. Among those practices, some can be validated, while others should be improved. The surveillance BeH-SAC does not have the means to assess the quality of the prescriptions made in a hospital, but can provide grounded figures allowing for the establishment of thresholds of “usual levels of consumption”. Hospitals getting results outside of this framework are encouraged to have a deeper look at their AM practices, to verify whether and how to improve them.

Concerning ampicillin and amoxicillin, which are penicillins with extended spectrum, NPD of primary hospitals are relatively grouped around a constant median of 20 DDD/1000 patient-days and in the same time, count a certain number of outliers. The variability in ICUs, regardless of the level of healthcare the hospital belongs to, is unsurprisingly wide (see also the Figures in the Appendices H1).

Figure 7.7. Trends and distribution of ampicillin and amoxicillin (J01CA01 & J01CA04) consumption in acute hospitals, per type of departments and level of healthcare, expressed in DDD / 1000 patient-days and in DDD / 1000 admissions, Belgium, 2007-2013
7.3.2. Combinations of penicillins and enzyme inhibitors (J01CR)

Amoxicillin & enzyme inhibitor and piperacillin & enzyme inhibitor (J01CR05 & J01CR02)

Globally, combinations of penicillins including an enzyme inhibitor (J01CR) are used in intensive care units (ICU) 1.5 times as much as in all non-paediatric wards grouped together. Regarding the combination amoxicillin and clavulanic acid, tertiary hospitals seem to share more common practices as compared to primary and secondary hospitals, especially in ICUs, where the level of consumption is lower and the variability of consumption is significantly reduced. Regarding the combination of piperacillin and tazobactam, all types of categorisation seem to indicate not only a raise of consumption, but also a raise of variability of consumption.

Figure 7.8. Trends and distribution of combinations of penicillins and enzyme inhibitors (J01CR) consumption in acute hospitals, per type of departments and level of healthcare, expressed in DDD / 1000 patient-days and in DDD / 1000 admissions, Belgium, 2007-2013
7.3.3. Third and fourth generation cephalosporins (J01DD & J01DE)

Together, the C3G and C4G display a very large variability in the use, both in ICU and in HAO of all three types of categorisation, per academic status, per level of healthcare and per category of hospital size (see complementary Figures in Appendices H3). The fact that NPD are less concerned by such a high variability is naturally justified by the severity and complexity of cases admitted in those ICU and HAO departments, as those molecules are last-resort treatments. It is also likely that local therapeutic practices and guidelines widely differ from one hospital to another. In this case, proposing national guidelines and targets might be fruitful with regard to the improvement of the antimicrobial prescription of third- and fourth-generation cephalosporins.

Figure 7.9. Trends and distribution of third- and fourth-generation cephalosporins (J01DD & J01DE) consumption in acute hospitals, per type of departments and level of healthcare, expressed in DDD / 1000 patient-days and in DDD / 1000 admissions, Belgium, 2007-2013
### 7.3.4. Carbapenems (J01DH)

According to the BeH-SAC data, there is a wide variation of carbapenems consumption, with a use in NPD of tertiary hospitals that is significantly higher than in other types of hospitals. The variability of carbapenems in ICUs of primary hospitals is larger than in ICUs of tertiary hospitals.

![Graph showing distribution and variability of carbapenems (J01DH) consumption per healthcare level, in Belgian acute hospitals](image)

**Figure 7.10.** Trends and distribution of carbapenems (J01DH) consumption in acute hospitals, per type of departments and level of healthcare, expressed in DDD / 1000 patient-days and in DDD / 1000 admissions, Belgium, 2007-2013
7.3.5. Colistin (J01XB01)

The consumption of colistin is associated with the cares provided in ICUs. In those specialised intensive wards, the variation of use goes from nearly zero to more than 100 DDD / 1000 patient-days. The median consumption is increasing from year to year in primary and in tertiary settings. Secondary hospitals seem on the contrary be better controlling their consumptions since the period 2010-2011, when it was at its maximum observed (see also Figures H5 in the Appendices).

![Graph showing the consumption of colistin (J01XB01) per healthcare level in Belgian acute hospitals](image)

Figure 7.11. Trends and distribution of colistin (J01XB01) consumption in acute hospitals, per type of departments and level of healthcare, expressed in DDD / 1000 patient-days and in DDD / 1000 admissions, Belgium, 2007-2013.
7.3.6. Fluoroquinolones (J01MA)

The use of fluoroquinolones (FQ) is mentioned as a risk factor for the appearance of acquired bacterial resistance, as well as for the selection of intrinsic resistant bacteria like *Clostridium difficile* [18]. Although the use of FQ in the ambulatory sector is, in Belgium, very high, the consumption of FQ in Belgian hospitals is reasonable as compared to other European countries. Moxifloxacin is, however, showing an increasingly level of consumption.

7.3.6.1. All fluoroquinolones except moxifloxacin

The categorisation per level of healthcare allows to distinguish different patterns between hospitals. Primary hospitals have both for the FQ in general and for moxifloxacin in particular a large variability. NPDs of secondary hospitals show a clear reduction of the variability of FQ consumption.

![Graph showing distribution and variability of fluoroquinolones except moxifloxacin (J01MA but J01MA14) consumption per healthcare level in Belgian acute hospitals](image)

Figure 7.12. Trends and distribution of fluoroquinolones (J01MA) consumption except moxifloxacin (J01MA14) in acute hospitals, per type of departments and level of healthcare, expressed in DDD / 1000 patient-days and in DDD / 1000 admissions, Belgium, 2007-2013
7.3.6.2. Moxifloxacin (J01MA14)

Figure 7.13. Trends and distribution of moxifloxacin (J01MA14) consumption in acute hospitals, per type of departments and level of healthcare, expressed in DDD / 1000 patient-days and in DDD / 1000 admissions, Belgium, 2007-2013

Graph per type of departments & healthcare level. See also Appendices for detailed figures.
Acute hospitals only.
7.3.7. Vancomycin and teicoplanin (J01XA01 & J01XA02)

Upon request from the working group ‘Hospital Medicine’, the consumption of vancomycin and teicoplanin have been summed up. Teaching hospitals are unsurprisingly showing a level of use significantly higher than non-teaching hospitals, regardless of the unit (NPD, ICU or HAO) where the observation is made. The analyses are showing that primary and small hospitals have a certain number of outliers (see additional Figures in Appendices, H7). Such different characteristics of use are indicating a field to be further investigated thanks to audits or diagnostic-based studies.

Figure 7.14. Trends and distribution of vancomycin and teicoplanin (J01XA01 & J01XA02) consumption in acute hospitals, per type of departments and level of healthcare, expressed in DDD / 1000 patient-days and in DDD / 1000 admissions, Belgium, 2007-2013
7.4. Relative antimicrobial consumption

Combinations of penicillins and enzyme inhibitors (J01CR) form the far most used subclass of antibacterial agents. The use of J01CR drugs remains quite stable in teaching hospitals, fluctuating around 210 DDD / 1000 patient-days between 2007 and 2013, while in non-teaching hospitals, it was rising from 205 in 2007 to 230 DDD / 1000 patient-days in 2012, then is dropping to its initial level in 2013. Due to the weight of this ATC class and the fact that more than 90% of Belgian hospitals are non-teaching ones, if the latter decline could be confirmed and sustained during the future years and without compensation on other ATC subclasses, it will have a substantial impact on the global national AMC in the hospital sector. J01CR indeed count for 41% and 31% of the total antibiotics (J01) use in respectively non-teaching and teaching hospitals in 2012. Studying further the proportions of most used ATC classes or products in non-paediatrics can be made based on Graph 7.15 (see also tables in the Appendices).

After the J01CR, the most frequently used antibiotics are the cephalosporins whose use is stable along the years (around 17% of all J01) and equivalent regardless of the academic status of hospitals. The group is constituted on the one hand by the first- (J01DB; C1G) and second-generation (J01DC; C2G) cephalosporins which are, relatively speaking, the most and increasingly consumed within the group, and on the other hand by the third- (J01DD; C3G) and fourth-generation (J01DE; C4G) cephalosporins which are less and less used in both types of hospitals. In Belgium, cefepime is the only fourth-generation cephalosporin used; its consumption has decreased by half since the start of the surveillance.

Then comes the group of fluoroquinolones (J01MA) with a relative weight of about 13% of all used antibiotics (J01). This class shows at the national level a very slight decrease from 2007 to 2013, despite a more manifest and regular decrease in the academic sector.

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**Figure 7.15.** Relative use (in % of DDD used) of different ATC antibacterial classes in non-paediatric departments of acute hospitals, per academic status, Belgium, 2007-2013

<table>
<thead>
<tr>
<th>ATC Code</th>
<th>ATC Name</th>
<th>Class Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>J01</td>
<td>Antibacterial agents for systemic use</td>
<td></td>
</tr>
<tr>
<td>J01C</td>
<td>β-lactam antibacterials, penicillins</td>
<td></td>
</tr>
<tr>
<td>J01CA</td>
<td>Penicillins with extended spectrum</td>
<td></td>
</tr>
<tr>
<td>J01CF</td>
<td>β-lactamase resistant penicillins</td>
<td></td>
</tr>
<tr>
<td>J01CR</td>
<td>Combinations of penicillins, including β-lactamase inhibitors</td>
<td></td>
</tr>
<tr>
<td>J01DE1C</td>
<td>Cefepime</td>
<td></td>
</tr>
<tr>
<td>J01D1H</td>
<td>Carbapenems</td>
<td></td>
</tr>
<tr>
<td>J01X1A</td>
<td>Glycopeptide antibacterials</td>
<td></td>
</tr>
<tr>
<td>C1G</td>
<td>1rst-generation cephalosporins</td>
<td></td>
</tr>
<tr>
<td>C3G</td>
<td>3rd-generation cephalosporins</td>
<td></td>
</tr>
<tr>
<td>C4G</td>
<td>4th-generation cephalosporins</td>
<td></td>
</tr>
<tr>
<td>J01MA</td>
<td>Fluoroquinolones</td>
<td></td>
</tr>
<tr>
<td>J01DD</td>
<td>2nd-generation cephalosporins</td>
<td></td>
</tr>
<tr>
<td>J01CE</td>
<td>Other antibacterials</td>
<td></td>
</tr>
<tr>
<td>J01DB</td>
<td>1st-generation cephalosporins</td>
<td></td>
</tr>
<tr>
<td>J01DC</td>
<td>2nd-generation cephalosporins</td>
<td></td>
</tr>
</tbody>
</table>

Legend:
- J01CR/J01C: 
- C1G+C2G/cephalo: 
- J01C/J01: 
- J01CR/J01: 
- C3G + C4G/cephalo: 
- J01CA/J01X: 
- all cephalo/J01: 
- J01CA/J01CR: 
- J01CA/J01C: 
- J01MA/J01: 
- J01CF/J01C: 
- J01D1H1/cephalo: 
- J01X/J01: 
- J01DH/J01: 
- J01CE/J01C: 

All acute hospitals
The ratio J01CA / J01CR (penicillins with extended spectrum / combinations of penicillins and enzyme inhibitors) serves as an indicator of appropriate antimicrobial stewardship practices. As regard to this indicator in Belgium, although the year 2013 seems to provide encouraging results, there is no clear trend demonstrating any ultimate successful application of local strategies on this aspects. β-lactamase resistant penicillins (J01CF), carbapenems (J01DH) as well as glycopeptide antibacterial agents (J01XA) are twice more used in teaching settings as compared to other hospitals (see Appendices, section E).

Table 7.1. Relative consumption (in % of DDD used) of systemic antibacterial agents in non-paediatric departments of acute hospitals, per academic status, BeH-SAC, Belgium, 2007-2013.

<table>
<thead>
<tr>
<th>J01C / J01</th>
<th>J01CR / J01</th>
<th>J01CA / J01CR</th>
<th>All cephalo / J01</th>
<th>J01DH / J01</th>
<th>J01MA / J01</th>
<th>J01X / J01</th>
</tr>
</thead>
<tbody>
<tr>
<td>49.5 50.6 51.0 50.7 50.7 51.4 49.6</td>
<td>39.8 41.2 41.4 41.0 41.1 41.3 38.5</td>
<td>12.4 11.6 11.3 11.5 11.1 12.1 13.8</td>
<td>17.1 16.5 15.9 16.2 17.0 16.6 18.5</td>
<td>2.9 3.1 3.4 3.5 3.5 3.3 3.3</td>
<td>13.9 13.7 13.4 14.0 13.9 13.6 13.2</td>
<td>7.3 7.1 7.3 7.1 6.7 6.7 6.9</td>
</tr>
<tr>
<td>43.9 44.0 44.2 44.2 44.1 45.5 45.3</td>
<td>29.9 29.6 30.2 29.1 29.8 30.8 29.6</td>
<td>17.4 20.0 17.8 21.0 20.2 20.1 22.7</td>
<td>17.7 18.4 18.6 17.8 17.8 16.7 17.0</td>
<td>5.9 5.6 5.3 6.0 6.1 6.4 6.7</td>
<td>13.2 12.5 12.8 11.7 11.2 10.5 10.2</td>
<td>7.5 8.1 8.1 8.9 9.1 8.9 8.7</td>
</tr>
<tr>
<td>48.1 49.3 49.7 49.5 49.4 50.2 48.6</td>
<td>37.3 39.0 39.3 38.8 38.9 39.1 36.4</td>
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J01: Antibacterial agents for systemic use  J01C: β-lactam antibacterials, penicillins  J01CR: Combinations of penicillins, including β-lactamase inhibitors  All cephalo: all cephalosporins  J01DH: Carbapenems  J01MA: Fluoroquinolones  J01X: Other antibacterial agents
8. Concluding remarks

Data of the mandatory Belgian surveillance of systemic antimicrobial consumption (AMC) for the years 2007-2013 are descriptively analysed. In non-pediatric units (NPD) and in terms of daily treatment (Defined Daily Doses [DDD] / 1000 patient-days), the global consumption of antibacterial agents (J01) in acute hospitals indicates at first an increase (median from circa 520 in 2007 to 560 DDD for 1000 days of hospitalisation in 2012); then the year 2013 shows a stabilisation or even a decrease of the AMC at 554 DDD / 1000 patient-days. Taken into account the variation across time in the lengths of stay, it appears that patients admitted in acute hospitals have received an average overall constant dose of 4 DDD of antimicrobial agents per stay.

Due to fragmentary data, national conclusions regarding chronic healthcare setting have a low level of representativeness. However, a tendency to a decreasing consumption is noticed. Trend analyses can be carried out at the hospital level.

In the non-pediatric sector, combinations of penicillins including an enzyme inhibitor (J01CR) form the far most used subclass of antimicrobial agents, followed by the four generations of cephalosporins combined together (J01DB, J01DC, J01DD & J01DE) and by the fluoroquinolones (J01MA). The penicillins (J01C) counted for more than 40% of the total antibiotics (J01) use. Over consecutive years, several of the more often administrated drugs are also more intensively used. This remark especially applies for ciprofloxacin, ceftriaxone, temocillin and flucloxacillin. In the same NPDs, the increasing usage of moxifloxacin seems to flatten during the two last available years, but requires anyway attention. Globally, the AMC is higher in teaching rather than in non-teaching hospitals. This difference particularly lean on all subclasses of penicillins (J01C) except combinations including an enzyme inhibitor (J01CR), the three first generations of cephalosporins and the nitrofuran derivatives (J01XE).

Small hospitals, who mostly have initiated an Antimicrobial Stewardship team (AMT) later (2006-2007 instead of 2002) have, according to their administrative reports, developed various stewardship local activities [19], although the impact of those efforts are difficult to identify at the national level.

On average in acute care hospitals, more than one patient out of five admitted in NPD and in haemato-oncology (HAO) is daily treated with a J01CR combinations as well as up to one out of three patients in intensive care units (ICU). The high variability of prescription for particular key products leading to higher level of antibacterial resistance, especially in ICUs of primary and secondary hospitals and in HAO units of tertiary hospitals would be interesting aspects to further investigate through more appropriate methodology and more detailed data sources. Globally, an important variability of consumption was seen in paediatrics, especially pronounced in non-teaching hospitals. But the analysis of the AMC in paediatrics remains difficult to perform, because of methodological limitations.

The aggregated data that are analysed in this report provide an overview both on the national level of consumption as well on the variability between hospitals and groups of hospitals. It is not the objective of the surveillance to look at the appropriateness of the prescribed treatment. Such a study requires more indication-driven data (as regard to the pathology and to patient’s characteristics), but can be efficiently guided thanks to the results obtained here. Because of the important workload that the data collection is imposing to the AMTs, the BeH-SAC’s Steering Committee has approved a change in the data collection methodology, whereby the same administrative information (invoicing data), routinely recorded are going to be re-used using a new and automatized data flow. The changes are currently under testing. Along with these adaptations, it would be useful, although not easy, to define clear statistical parameters, indicators and targets for the Belgian context, as well as specific products and hospital wards, for which the national AMC consumption should be carefully monitored.
The control of antimicrobial resistances in hospitals leans on several complementary approaches, among which antimicrobial stewardship programmes are cornerstones [20]. The surveillance of hospital antimicrobial consumption should be associated with complementary outcomes measurements such as the antimicrobial resistance and the patients’ outcomes [21]. This field of activity is still in an early stage and different methodological tools and indicators are used in different contexts [21,22,23]. Furthermore, international works and agreements on these methodological issues are much expected and should be further supported.

Regarding the BeH-SAC, the accurate specification of which hospital sites do participate under a leading site is not clearly available. Nor is the possibility to check that all the concerned wards and beds are indeed included into the consumption datasets that hospitals have delivered. Let us notice that if within a “merger”, data for each and all specific sites were not provided, it is assumed that aggregated data have been delivered under the code of the principal hospital site. When the composition of a merger changes (a site is detached or on the contrary is integrated), often the whole structure of the hospital is modified: the bed-capacity is different, some medical specialities can be reorganized, etc. This is likely to alter the hospital case-mix and can ultimately influence the global AMC consumption. Moreover, such changes take place most of the during at some point during the year, which means that the yearly aggregated data that will be provided by the hospital cover at least two different settings. The surveillance is not able to take these changes into account and cannot archive them for information. At the national level, these approximations are balancing each other; the global Belgian trends are likely equally meaningful. On the contrary, they have an impact on the local interpretation of results and AMTs have the responsibility to integrate their own historical facts while analysing their performances. The tendency in Belgium is a greater specialisation of sites and the constitution of larger mergers, with an overall declining number across the time.

Beside the DDD unit of measurement, the surveillance BeH-SAC would much benefit from the update and validation of the existing Daily Dose Administred (DDA) list, another unit of measurement specifically developed and adapted to the Belgian context, which could hence be integrated in future national and hospital-based analyses. The national AMC trends should be better described when using the DDA. Especially concerning the monitoring of the paediatric consumption, a reliable and comprehensive list of DDA would be a key tool of assessment. Obviously, the making of that DDA list requires time and expertise, among other precious resources.
References


