BELGIAN HOSPITALS – SURVEILLANCE OF ANTIMICROBIAL CONSUMPTION (BEH-SAC)

15-year evolution (2003-2017) of antimicrobial consumption in Belgian hospitals

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Belgian Hospitals – Surveillance of Antimicrobial Consumption (BeH-SAC)

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VANDAEL E.[1]

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MAGERMAN K.[2,3]

•

CATRY B.[1]

In collaboration with

Versporten A.[2,4], Goossens H.[2,4], Coenen S.[2,4], Van Aubel X.[5], Mahmourian T.[6], Quesada J.[6]

1. Sciensano, Healthcare-associated infections and antimicrobial resistance, Brussels
2. Belgian Antibiotic Policy Coordination Committee (BAPCOC), Brussels
3. Jessa hospital, Hasselt
4. University of Antwerp, Laboratory of Medical Microbiology, Vaccine & Infectious Disease Institute (VAXINFECTIO), Antwerp
5. National Institute for Health and Disability Insurance (NIHDI-RIZIV-INAMI), Research, Development & Quality, Brussels
6. Sciensano, Healthdata, Brussels

Eline Vandael • T+32 2 642 50 26 • eline.vandael@sciensano.be

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Partners

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ABBREVIATIONS

- ABUH = Antibiotic Use in Hospitals
- ATC = Anatomical Therapeutic Chemical Classification
- BAPCOC = Belgian Antibiotic Policy Coordination Committee
- BeH-SAC = Belgian Hospitals – Surveillance of Antimicrobial Consumption
- DDD = Defined Daily Dose
- ECDC = European Center for Disease Prevention and Control, Stockholm, SE
- EFSA = European Food Safety Authority
- EMA = European Medicines Agency
- ESAC-Net = European Surveillance of Antimicrobial Consumption network
- INAMI = Institut National d'Assurance Maladie-Invalidité
- IQR = interquartile range
- NIHDI = National Institute for Health and Disability Insurance (RIZIV-INAMI)
- NSIH = National Surveillance of Infections in Healthcare settings
- RIZIV = Rijksinstituut voor ziekte- en invaliditeitsverzekering
- WHO = World Health Organisation

EXECUTIVE SUMMARY

Background

Studies abundantly have demonstrated the link between antimicrobial consumption and the development of antimicrobial resistance. Surveillance of antimicrobial consumption is one of the action points of the 'One Health Action Plan against Antimicrobial Resistance' of the European Commission (https://ec.europa.eu/health/amr/action_eu_en). Besides ESAC-Net (European Surveillance of Antimicrobial Consumption network, https://ecdc.europa.eu/en/antimicrobial-consumption/surveillance-and-disease-data/database), which only contains aggregated data of consumption (for the whole country population) per European country, a more detailed surveillance of antimicrobial consumption was set up in Belgian hospitals with the possibility to compare with other hospitals (benchmark). Between 2007 and 2014, hospitals were obligated (the ABUH project) to annually upload their consumption data on a web-based data collection application of Sciensano called NSIHweb. After 2014, hospitals could voluntarily continue with this system for local monitoring, while a follow-up project called BeH-SAC (Belgian Hospitals - Surveillance of Antimicrobial Consumption), was introduced. BeH-SAC uses reimbursement data of the National Institute for Health and Disability Insurance (NIHDI) in combination with a new reporting system on Healthstat.

Methods

Reimbursement data (2003-2017) were collected from the NIHDI, and consisted of both numerator (consumed units per drug; WHO ATC-codes: A07A, D01BA, J01, J02, P01AB, J04A, J05) and denominator data (patient days and admissions) collected per year/trimester and per hospital/unit (including surgery, internal medicine, geriatrics, pediatrics, intensive and non-intensive neonatology, maternity, infectious disease, burn unit, intensive care, specialized care). Numerator data were translated in defined daily doses (DDDs); the antimicrobial consumption was expressed in DDDs/1000 patient days and DDDs/1000 admissions.
A comparison was made with the results of the old methodology (ABUH) for overlapping hospitals and years (2007-2014).

Results

Between BeH-SAC and ABUH (N=98 hospitals), an overall median absolute difference in antibiotic consumption (J01) of 3.09% (interquartile range (IQR) 1.28-8.02; outliers >50% difference: N=13) in DDDs/1000 patient days and 3.94% (IQR 1.66-13.24; outliers >50% difference: N=15) in DDDs/1000 admissions was found.

The median consumption of antibacterials for systemic use (J01) in acute care Belgian hospitals (N=102) was 592.6 DDDs/1000 patient days in 2017, with a high variation between hospitals (see Figure 1). Between 2003 and 2017, there was an increase in the median DDDs/1000 patient days (+25.5 DDDs/1000 patient days, +4.5%) and, between 2008 and 2016, a decrease in the median DDDs/1000 admissions (-284.2 DDDs/1000 admissions, -6.8%). The antibiotic consumption was higher in tertiary hospitals (N=7, median in 2017: 727.8 DDDs/1000 patient days). 'Combinations of penicillins with beta-lactamase inhibitors' (J01CR) was the most used subclass, followed by 'Fluoroquinolones' (J01MA). The total consumption of broad-spectrum antibiotics in all acute care hospitals in 2017 was 179.7 DDDs/1000 patient days (% of J01: 29.1%).

Feedback reports per hospital are provided on an interactive platform Healthstat, with benchmarking and stratification at different levels (per kind (acute/chronic/psychiatric), type (primary/secondary/tertiary/specialized), size (based on the number of beds)).

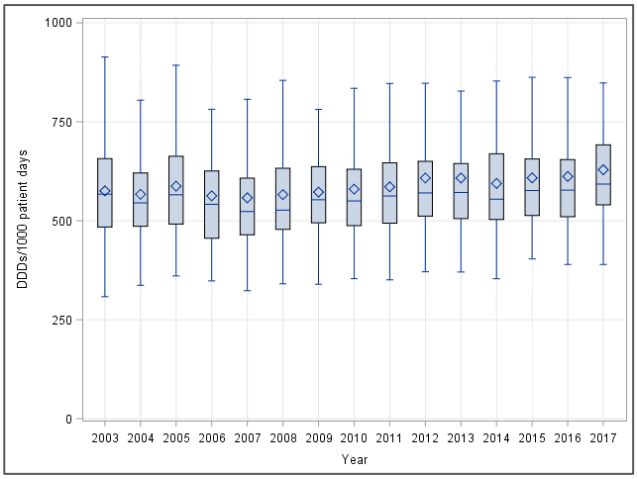
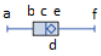


Figure 1: Evolution of the consumption of antibacterials for systemic use (J01) in acute care Belgian hospitals (N=102), expressed in defined daily doses (DDDs)/1000 patient days (2003-2017) – Belgian Hospitals - Surveillance of Antimicrobial Consumption (BeH-SAC)

Legend boxplot: a. maximum (without outliers, 1.5x interquartile range), b. 75 percentile (P75), c. median, d. mean, e. 25 percentile (P25), f. minimum (without outliers, 1.5x interquartile range)



Conclusions

Main advantages of BeH-SAC in comparison with the old methodology are a lower workload for the hospitals, a decreased variation in data collection, and a new reporting system. Outliers in the comparison between BeH-SAC and ABUH demonstrate the known heterogeneity in the data collection of ABUH, and the more uniform data collection in BeH-SAC. The methodology of the surveillance can further be improved with stratified data, e.g. per diagnosis, and a shorter delay between consumption and reporting (real-time feedback).

The median antibiotic consumption in acute care Belgian hospitals in 2017 remained similar to the previous years. In the 15-period (2003-2017), there was a small increase in the median consumption in DDDs/1000 patients and a small decrease (2008-2016) in DDDs/1000 admissions. The high variation in antibiotic consumption between acute care hospitals and the high use of broad-spectrum antibiotics (especially fluoroquinolones) should be targets for improvement.

SAMENVATTING

Achtergrond

Verschillende studies hebben de link tussen antimicrobiële consumptie en resistentie aangetoond. Surveillance van antimicrobiële consumptie is één van de actiepunten in het *'One Health Action Plan against Antimicrobial Resistance*' van de Europese Commissie (https://ec.europa.eu/health/amr/action_eu_en). Naast ESAC-Net (European Surveillance of Antimicrobial Consumption network, https://ecdc.europa.eu/en/antimicrobial-consumption/surveillance-and-disease-data/database), dat enkel geaggregeerde gegevens over het gebruik (voor de totale populatie) per Europese lidstaat omvat, werd er in België eveneens een meer gedetailleerde surveillance van de antimicrobiële consumptie per ziekenhuis opgezet. Dit biedt de mogelijkheid om zich te vergelijken met andere ziekenhuizen (benchmark). Tussen 2007-2014 werden ziekenhuizen verplicht om jaarlijks facturatiegegevens over deze consumptie op te laden op het NSIH-web van Sciensano, in het kader van het ABUH-project. Sinds 2014 kunnen ziekenhuizen dit systeem nog steeds vrijwillig gebruiken voor lokale monitoring. Ondertussen werd ook het opvolgproject BeH-SAC (Belgian Hospitals - Surveillance of Antimicrobial Consumption) voorgesteld. In BeH-SAC worden administratieve gegevens van het Rijksinstituut voor ziekte- en invaliditeitsverzekering (RIZIV) gebruikt en is er een nieuwe rapportage op Healthstat.

Methoden

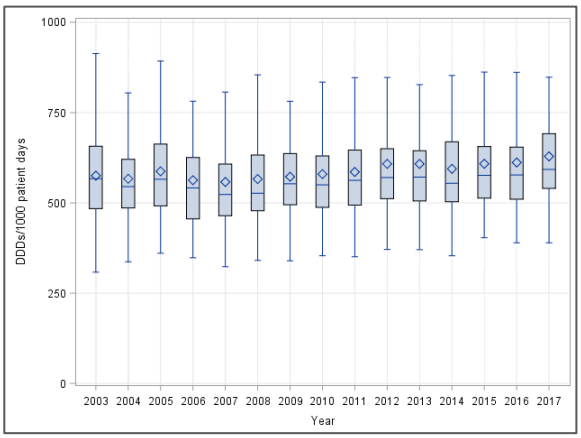
Administratieve gegevens (2003-2017) werden verzameld bij het RIZIV, zowel tellergegevens (het verbruikt aantal eenheden per geneesmiddel; WHO ATC-codes: A07A, D01BA, J01, J02, P01AB, J04A, J05) als noemergegevens (ligdagen en opnames), opgedeeld per jaar/trimester en per ziekenhuis/afdeling (inclusief chirurgie, interne geneeskunde, geriatrie, pediatrie, intensieve en niet-intensieve neonatologie, materniteit, infectieziekten, brandwonden, intensieve zorgen, gespecialiseerde afdelingen). De tellergegevens werden vertaald in *defined daily doses* (DDDs); de consumptie werd uitgedrukt in DDDs/1000 ligdagen en DDDs/1000 opnames.
Er werd een vergelijking gemaakt met de resultaten bekomen met de oude methodologie (ABUH) voor de overlappende ziekenhuizen en jaren (2007-2014).

Resultaten

Tussen de resultaten bekomen met BeH-SAC en ABUH (N=98 ziekenhuizen) werd er voor antibiotica consumptie (J01) een mediaan absoluut verschil gevonden van 3.09% (interkwartiel range (IQR) 1.28-8.02; outliers >50% verschil: N=13) in DDDs/1000 ligdagen en 3.94% (IQR 1.66-13.24; outliers >50% verschil: N=15) in DDDs/1000 opnames.

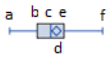
De mediane antibioticaconsumptie (J01) in Belgische acute ziekenhuizen (N=102) was 592.6 DDDs/1000 ligdagen in 2017, met een hoge variatie tussen de ziekenhuizen (zie Figuur 1). Tussen 2003 en 2017 was er een stijging in het mediane verbruik in DDDs/1000 ligdagen (+25.5 DDDs/1000 ligdagen, +4.5%) en, tussen 2008 en 2016, een daling in het mediane verbruik in DDDs/1000 opnames (-284.2 DDDs/1000 opnames, -6.8%). De antibioticaconsumptie was hoger in tertiaire ziekenhuizen (N=7, mediaan: 727.8 DDDs/1000 ligdagen). 'Combinaties van penicillines met beta-lactamase inhibitoren' (J01CR) was de meeste gebruikte antibioticaklasse, gevolgd door de 'Fluoroquinolones' (J01MA). De totale consumptie van breedspectrum antibiotica bedroeg 179.7 DDDs/1000 ligdagen in 2017 (% van J01: 29.1%).

Feedbackrapporten per ziekenhuis zijn beschikbaar op een interactief platform Healthstat, met benchmarking en stratificatie op verschillende niveaus (per soort (acuut/chronisch/psychiatrisch), per type (primair/secundair/tertiair/gespecialiseerd) en grootte (op basis van het aantal bedden)).



Figuur 1: Evolutie van de consumptie van antibiotica voor systemisch gebruik (J01) in Belgische acute ziekenhuizen (N=102), uitgedrukt in defined daily doses (DDDs)/1000 ligdagen (2003-2017) – Belgian Hospitals - Surveillance of Antimicrobial Consumption (BeH-SAC)

Legende boxplot: a. maximum (zonder outliers, 1.5x interquartile range), b. 75 percentiel (P75), c. mediaan, d. gemiddelde, e. 25 percentiel (P25), f. minimum (zonder outliers, 1.5x interquartile range)



Conclusies

De belangrijkste voordelen van BeH-SAC ten opzichte van de oude methodologie zijn de verminderde registratielast voor ziekenhuizen, de verminderde variatie in de datacollectie en een nieuw rapportagesysteem. Outliers in de vergelijking tussen BeH-SAC en ABUH tonen de gekende variatie in de datacollectie in ABUH aan, en de meer uniforme datacollectie in BeH-SAC. De methodologie van deze surveillance kan verder verbeterd worden door een meer gedetailleerde feedback per diagnose en een kortere vertraging tussen het verbruik en de rapportage (*real-time feedback*).

Het mediane antibioticaverbruik in Belgische acute ziekenhuizen in 2017 bleef gelijkaardig als de vorige jaren. Tussen 2003 en 2017 was er een kleine stijging in het mediane antibioticaverbruik in DDDs/1000 ligdagen en een kleine daling (2008-2016) in DDDs/1000 opnames. De hoge variatie in antibioticaverbruik tussen acute ziekenhuizen en het hoge verbruik van breedspectrum antibiotica (voornamelijk fluoroquinolones) zijn aandachtspunten voor verbetering.

RÉSUMÉ

Contexte

De nombreuses études ont démontré le lien entre la prise d'agents antimicrobiens et l'apparition d'une résistance. La surveillance de la consommation antimicrobienne est l'un des points d'action du « *One Health Action Plan against Antimicrobial Resistance* » de la Commission européenne (https://ec.europa.eu/health/amr/action_eu_en). En plus du réseau ESAC-Net (*European Surveillance of Antimicrobial Consumption network*, https://ecdc.europa.eu/en/antimicrobial-consumption/surveillance-and-disease-data/database), qui ne contient que des données agrégées de consommation (pour l'ensemble de la population du pays) par pays européen, la Belgique a mis en place une surveillance plus détaillée de la consommation d'antimicobiens pour chaque hôpital, qui permet une comparaison d'un établissement à un autre (benchmark). De 2007 à 2014, les hôpitaux ont été tenus, dans le cadre du projet ABUH, de télécharger sur une application de Sciensano (NSIH-web) leurs données de facturation annuelles relatives à cette consommation. Après 2014, les hôpitaux ont pu continuer à utiliser ce système, mais sur une base volontaire. Le projet de suivi BeH-SAC (*Belgian Hospitals - Surveillance of Antimicrobial Consumption*) a, depuis lors, également été introduit. Ce projet consiste en l'utilisation des données administratives de l'Institut national d'assurance maladie-invalidité (INAMI), en combinaison avec un nouveau système d'enregistrement sur Healthstat.

Méthodes

Des données administratives (2003-2017) ont été recueillies auprès de l'INAMI. Il s'agissait aussi bien de données du numérateur (nombre d'unités consommées par médicament; codes ATC de WHO: A07A, D01BA, J01, J02, P01AB, J04A, J05) que de données du dénominateur (nombre de jours d'hospitalisation et nombre d'admissions), réparties par année/trimestre et par hôpital/unité (y compris chirurgie, médecine interne, gériatrie, pédiatrie, néonatologie intensive et non intensive, maternité, maladies infectieuses, grands brûlés, soins intensifs, unités spécialisées). Les données du numérateur ont été traduites en *defined daily doses* (DDDs); la consommation a été exprimée en DDD pour 1000 journées d'hospitalisation et en DDD pour 1000 admissions.
Une comparaison a été effectuée avec les résultats de l'ancienne méthodologie (ABUH) pour les hôpitaux et les années (2007-2014) qui se chevauchent.

Résultats

Entre BeH-SAC et ABUH (N=98 hôpitaux), un écart médian absolu de la consommation d'antibiotiques (J01) de 3.09% (interquartile range (IQR) 1.28-8.02; valeurs aberrantes >50% différence: N=13) en DDD/1000 journées d'hospitalisation et de 3.94% (IQR 1.66-13.24; valeurs aberrantes >50% différence: N=15) en DDD/1000 admissions a été constatée.

La consommation médiane d'antibiotiques à usage systématique (J01) dans les hôpitaux belges aigus (N=102) s'élevait à 592.6 DDD/1000 journées d'hospitalisation en 2017, avec une forte variation entre les hôpitaux (voir Figure 1). Entre 2003 et 2017, la consommation médiane en DDDs/1000 journées d'hospitalisation a augmenté (+25.5 DDDs/1000 journées d'hospitalisation, +4.5%) et, entre 2008 et 2016, la consommation médiane en DDDs/1000 admissions a diminué (-284.2 DDDs/1000 admissions, -6.8%). La consommation d'antibiotiques était plus élevée dans les hôpitaux tertiaires (N=7, médiane: 727.8 DDD/1000 journées d'hospitalisation). Les classes d'antibiotiques les plus utilisées étaient les combinaisons pénicilline – inhibiteur de bêta-lactamase (J01CR), suivies par les fluoroquinolones (J01MA). La consommation totale d'antibiotiques à large spectre dans les hôpitaux aigus s'élevait à 179.7 DDD /1000 journées d'hospitalisation en 2017 (% de J01: 29.1%).

Les rapports de feed-back individuels pour chaque hôpital sont publiés sur une plateforme interactive (Healthstat), avec un *benchmarking* et une stratification à différents niveaux (par catégorie (aigu, chronique, psychiatrique), par type (primaire, secondaire, tertiaire, spécialisé) et par taille (sur la base du nombre de lits)).

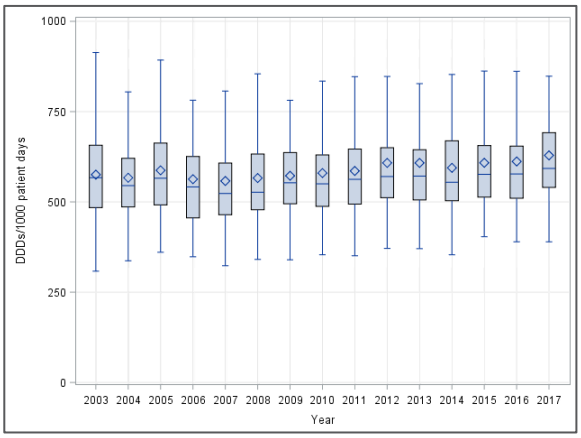
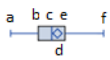


Figure 1 : Évolution de la consommation d'antibiotiques à usage systémique (J01) dans les hôpitaux belges aigus (N=102), exprimée en DDD pour 1000 journées d'hospitalisation (2003-2017) – Belgian Hospitals - Surveillance of Antimicrobial Consumption (BeH-SAC)

Légende du boxplot: a. maximum (valeurs aberrantes exclues, 1,5x écart interquartile), b. percentile 75 (P75), c. médiane, d. moyenne, e. percentile 25 (P25), f. minimum (valeurs aberrantes exclues, 1,5x écart interquartile)



Conclusions

Les principaux avantages que présente le système BeH-SAC par rapport à l'ancienne méthodologie sont les suivants: réduction de la charge de travail des hôpitaux, diminution des variations dans le recueil des données et un nouveau système de rapportage. Les valeurs aberrantes dans la comparaison entre BeH-SAC et ABUH démontrent l'hétérogénéité connue dans la collecte des données de l'ABUH et la collecte de données plus uniforme dans BeH-SAC. Il est encore possible d'améliorer la méthodologie de cette surveillance en stratifiant les données, par diagnostic par exemple, et en réduisant le délai entre la consommation et le rapportage (*real-time feedback*).

La consommation médiane d'antibiotiques dans les hôpitaux belges aigus en 2017 est restée comparable à celle des années précédentes. Entre 2003 et 2017, il y a eu une légère augmentation de la consommation médiane d'antibiotiques en DDDs/1000 journées d'hospitalisation et une légère diminution (2008-2016) en DDDs/1000 admissions. La grande variation de la consommation d'antibiotiques entre les hôpitaux aigus et l'utilisation élevée d'antibiotiques à large spectre (en particulier les fluoroquinolones) devraient être des points à améliorer.

INTRODUCTION

In 2001, the European Council ordered the Member States to encourage the rational use of antimicrobial agents in their countries. In June 2017, the importance of the surveillance of this antimicrobial use was again underlined in the new 'One Health Action Plan against Antimicrobial Resistance' of the European Commission (1).

ESAC-Net (European Surveillance of Antimicrobial Consumption network) is the European network of national surveillance systems of antimicrobial consumption, organized by the European Center for Disease Prevention and Control (ECDC). Using a shared methodology, different European countries are collecting antimicrobial consumption data in the ambulant and/or hospital sector, which are subsequently expressed in DDDs (Defined Daily Dose) per 1000 inhabitants per day. The results are publically available in an interactive database on the website of the ECDC (2).

Belgium has played a leading role in the development and implementation of surveillance systems on antimicrobial consumption and resistance. These efforts can be partly explained by the high antimicrobial consumption in Belgium in comparison with the neighboring countries. These surveillances are being followed up by the dedicated working groups of the Belgian Antibiotic Policy Coordination Committee (BAPCOC) (3).

Besides ESAC-Net, which only contains aggregated data of all Belgian hospitals expressed by inhabitants (whole country population, not specific for the hospital population), a more detailed surveillance of antimicrobial consumption (expressed in DDDs/1000 patient days and DDDs/1000 admissions) was set up in Belgian hospitals, with the possibility to benchmark with other hospitals. Between 2007 and 2014, in the ABUH (Antibiotic Use in Hospitals) project, acute care and large (≥150 beds) chronic care hospitals were obligated to annually upload their consumption data on a web-based data collection application of Sciensano (formerly WIV-ISP) called NSIHweb (4,5). This mandatory surveillance of antimicrobial consumption was part of the funding that these hospitals receive for the implementation of antimicrobial management teams (6). From 2014 onwards, hospitals could voluntarily continue with this system for local monitoring, while a follow-up project called BeH-SAC (Belgian Hospitals - Surveillance of Antimicrobial Consumption*)*, was introduced. BeH-SAC uses reimbursement data of the National Institute for Health and Disability Insurance (NIHDI) in combination with a new reporting system on Healthstat. More information concerning ABUH and the transfer to BeH-SAC can be found on the NSIH-website: http://www.nsih.be/surv_gm/introduction_en.asp.

The **objectives** of BeH-SAC are:

- To develop and offer a scientifically standardized methodology to Belgian hospitals, to follow-up their antimicrobial consumption in a quantitative way through time (in complement to their own local and in-depth monitoring).
- To give Belgian hospitals the opportunity to benchmark, based on their antimicrobial consumption, with similar hospitals.
- To provide national and regional data (with an acceptable delay in time) to be able to evaluate the antimicrobial consumption in Belgian hospitals.

The objective of this national report is to describe the 15-year evolution (2003-2017) of antimicrobial use in Belgian hospitals using the data of a new national surveillance system (BeH-SAC) and to compare the results of this new methodology with the old methodology (ABUH).

METHODOLOGY

DATA COLLECTION

Reimbursement data are collected from the NIHDI, and consist of both numerator (consumed units per drug; WHO ATC-codes: A07A, D01BA, J01, J02, P01AB, J04A, J05 (7)) and denominator data (patient days and admissions) collected per year/trimester and per hospital/unit. Numerator and denominator data can be linked with each other based on the unique NIHDI number per hospital. Table 1 presents an overview of the currently available data in the BeH-SAC database (version January 2019).

Table 1: Overview of the available parameters in the BeH-SAC database

Parameters	Values
Year + trimester	2003-2017
Numerator	Consumed units per drug, translated in DDDs
Denominator	Number of patients days (2003-2017) Number of admissions (2008-2016, not available for psychiatric hospitals, collected separate per trimester and per year to avoid doubles*)
Drugs coded with ATC-codes (4)	A07A = Intestinal anti-infectives J01 = Antibacterials for systemic use J02 + D01BA = Antimycotics and antifungals for systemic use P01AB = Nitroimidazole derivatives used orally and rectally as antiprotozoals J04A = Drugs for treatment of tuberculosis J05 = Antivirals for systemic use (only starting from 2015)
Hospitals	Acute care, chronic care and psychiatric hospitals Identified based on the NIHDI-number Coded per kind (acute care, chronic care, psychiatric), type (primary, secondary, tertairy, specialized), size (large (>600 beds), medium (400-600 beds), small (<400 beds)) and region (Brussels, Flanders, Wallonia)
Hospital units (NIHDI codes)	Neonatology non-intensive (190) Surgery (210) Internal medicine (220) Pediatrics (230) Infectious diseases (250) Maternity (260) Neonatology intensive care (270) Burn unit (290) Geriatrics (300) Surgical day hospitalizations (320) Neuropsychiatry Pediatrics (340-350-360) Neuropsychiatry (370-380-390) Psychiatry (410-420-430) Psychiatry ICU (480) ICU (490, including ICU surgery, ICU internal medicine, ICU pediatrics, ICU mixed, ICU maternity) Specialized care (610: cardio-pulmonary, 620: locomotive, 630: neurological, 640: chronic - palliative care, 650: chronic – polypathology, 660: psycho-geriatrics, 690: in transition)

ATC = Anatomical Therapeutic Chemical classification; BeH-SAC = Belgian Hospitals – Surveillance of Antimicobial Consumption; DDD = defined daily dose; ICU = intensive care unit; NIHDI = National Institute for Health and Disability Insurance

* Patients staying in the hospital in several trimesters are not counted double in the total per year.

Non-reimbursed off-label use of these antimicrobial agents or use of imported antimicrobials agents from other countries are not taken into account. It was estimated that in 2016 approximately 99% of the Belgian population was covered by a health insurance and consequently are included in the data of NIHDI (8).

DATA ANALYSIS

In the current report, the following units were included for acute and chronic care hospitals: surgery (210), internal medicine (220), geriatrics (300), pediatrics (230), intensive (270) and non-intensive neonatology (190), maternity (260), infectious disease (250), burn unit (290), intensive care (ICU, 490)) and specialized care (610-620-630-640-650-660-690). In line with the original ABUH protocol, psychiatric units and day hospitalizations were excluded for these hospitals. Only for psychiatric hospitals, the units neuropsychiatry pediatrics (340-350-360), neuropsychiatry (370-380-390), psychiatry (410-420-430), psychiatry ICU (480) and specialized care (psycho-geriatrics, 660) were included. Analyses per unit are only expressed in DDDs/1000 patient days, because misclassification bias can occur in the number of admissions per unit (when patients stay at different units during one admission).

Numerator data were translated in defined daily doses (DDDs) based on the DDD-classification of WHO (version February 2018) (7). Because the list of DDDs is updated every year, this can lead to a variation in the published results through time. The antimicrobial consumption is expressed in DDDs/1000 patient days and DDDs/1000 admissions. The percentage of consumed DDDs of broad-spectrum antibacterials among all antibacterials for systemic use (J01) was calculated in line with the outcome indicators jointly proposed by ECDC, the European Food Safety Authority (EFSA) and the European Medicines Agency (EMA) (9). The following products were included as broad-spectrum: piperacillin in combination with a beta-lactamase inhibitor (J01CR05), third- and fourth-generation cephalosporins (J01DD and J01DE), monobactams (J01DF), carbapenems (J01DH), fluoroquinolones (J01MA), glycopeptides (J01XA), polymyxins (J01XB), daptomycin (J01XX09) and oxazolidinones: linezolid (J01XX08) and tedizolid (J01XX11) (9).

Hospitals are classified per kind (acute care, chronic care, psychiatric), per type (primary, secondary, tertiary, specialized), per size (large (>600 beds), medium (400-600 beds), small (<400 beds)) and region (Brussels, Flanders, Wallonia) based on a list of hospitals of the Belgian Ministry of Health (Dienst Datamanagement - Directoraat-Generaal Gezondheidszorg, version 2/2018) and classified according to the definitions of ECDC.

Data-analyses were performed with SAS Enterprise Guide 7.1. Median and interquartile range (IQR) were calculated where appropriate. Boxplots were used to present the evolution of the consumption and the variability between hospitals.

COMPARISON WITH THE OLD METHODOLOGY

A comparison was made between the results of ABUH (old methodology, self-reported data) and BeH-SAC (new methodology, reimbursement data) for the overall antibiotic (J01) consumption (for overlapping years (2007-2014) and for all hospitals for which data were available). Note: In ABUH consumptions related to psychiatric beds were only included in the numerator, while in BeH-SAC psychiatric beds were excluded in both the numerator and denominator. Day care admissions were excluded in both databases.

The following analyses were performed:

- calculation of the differences (%) in the annual median J01 consumption in all included hospitals, for the total hospital use and specifically for ICU;

- calculation of the median of the differences (%) per hospital and per year, for the total hospital use and specifically for ICU;
- analysis of the outliers (>50% difference between ABUH and BeH-SAC);
- calculation and comparison of the trends in J01 consumption between ABUH and BeH-SAC. Trends over time were evaluated with the Mann-Kendall test. P-values less than 0.05 were considered statistically significant.

Due to the known heterogeneity in the data collection in ABUH, we expect to have some outliers. Therefore, in this comparison, the focus was put on the medians.

PROTOCOL

For more details about the methodology of BeH-SAC, please consult the protocol on the NSIH-website:
http://www.nsih.be/surv_gm/download_nl.asp
http://www.nsih.be/surv_gm/download_fr.asp

RESULTS

PARTICIPATING HOSPITALS IN BEH-SAC

In 2017, 102 acute care hospitals, 13 chronic care hospitals and 55 psychiatric hospitals were included in the data collection. More details can be found in Table 2-4.

Table 2: Description of the included acute care Belgian hospitals (2003-2017)

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Total	104	104	104	104	105	105	105	105	105	105	105	104	102	102	102
Type:															
Primary	80	80	80	80	80	80	80	80	80	80	80	79	77	77	77
Secondary	16	16	16	16	17	17	17	17	17	17	17	17	17	17	17
Tertiary	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7
Specialized	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Size:															
Large (>600 beds)	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27
Medium (400-600 beds)	27	27	27	27	27	27	27	27	27	27	27	26	26	26	26
Small (<400 beds)	50	50	50	50	51	51	51	51	51	51	51	51	49	49	49
Region:															
Flanders	55	55	55	55	55	55	55	55	55	55	55	55	54	54	54
Wallonia	37	37	37	37	38	38	38	38	38	38	38	37	36	36	36
Brussels	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
Mean length of stay	NA*	NA*	NA*	NA*	NA*	7.7	7.4	7.4	7.2	7.1	6.9	6.9	6.8	6.7	NA*

* Number of admissions, needed to calculate the mean length of stay, only available for the period 2008-2016

Table 3: Description of the included chronic care Belgian hospitals (2003-2017)

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Total	19	19	19	19	19	19	19	19	19	19	19	18	16	13	13
Type:															
Primary	8	8	8	8	8	8	8	8	8	8	8	7	7	4	4
Secondary	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tertiary	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Specialized	11	11	11	11	11	11	11	11	11	11	11	11	9	9	9
Size:															
≥150 beds	7	7	7	7	7	7	7	7	7	7	7	7	7	6	6
<150 beds	12	12	12	12	12	12	12	12	12	12	12	11	9	7	7
Region:															
Flanders	10	10	10	10	10	10	10	10	10	10	10	9	9	8	8
Wallonia	5	5	5	5	5	5	5	5	5	5	5	5	5	3	3
Brussels	4	4	4	4	4	4	4	4	4	4	4	4	2	2	2
Mean length of stay	NA*	NA*	NA*	NA*	NA*	42.1	40.7	42.3	41.7	41.2	40.4	39.5	38.4	38.5	NA*

* Number of admissions, needed to calculate the mean length of stay, only available for the period 2008-2016

Table 4: Description of the included psychiatric Belgian hospitals (2003-2017)

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Total	58	58	59	59	59	59	60	60	60	59	58	59	59	58	55
Type:															
Specialized	58	58	59	59	59	59	60	60	60	59	58	59	59	58	55
Size:															
Large (>600 beds)	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Medium (400-600 beds)	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
Small (<400 beds)	49	49	50	50	50	50	51	51	51	50	49	50	50	49	46
Region:															
Flanders	34	34	35	35	35	35	35	35	35	35	34	34	34	33	32
Wallonia	18	18	18	18	18	18	18	18	18	18	18	18	17	17	17
Brussels	6	6	6	6	6	6	7	7	7	6	6	7	8	8	6

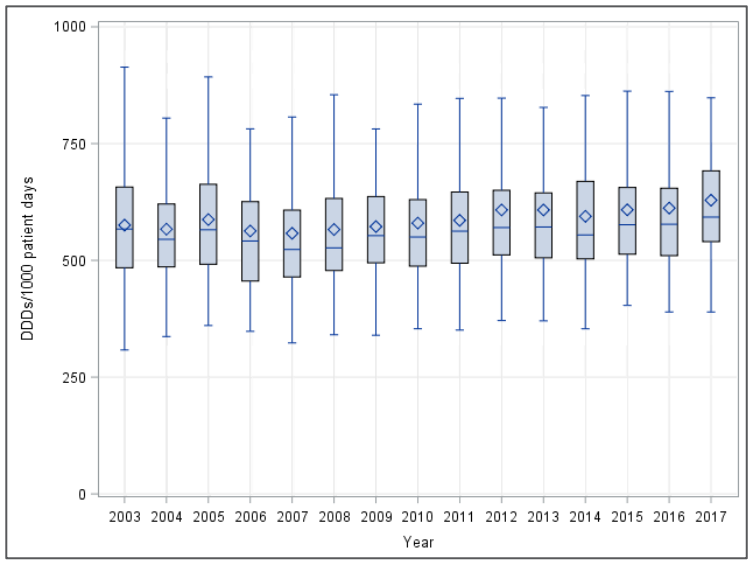
* Number of admissions not available for psychiatric hospitals, so the mean length of stay could not be calculated

MAIN RESULTS IN BEH-SAC

Acute care hospitals

Overall antibiotic consumption (hospital-wide)

The median consumption of antibacterials for systemic use (J01) in 2017 in acute care Belgian hospitals (N=102) was 592.6 DDDs/1000 patient days (increase of 25.5 DDDs/1000 patient days (+4.5%) in comparison with 2003, increase of 15.3 DDDs/1000 patient days (+2.7%) in comparison with 2016).
Expressed in DDDs/1000 admissions, the median antibiotic consumption in 2016 was 3890.3 (decrease of 284.2 DDDs/1000 admissions (-6.8%) in comparison with 2008, decrease of 22.2 DDDs/1000 admissions (-0.6%) in comparison with 2015). In Figure 1, the evolution of the antibiotic consumption between 2003-2017 is shown in DDDs/1000 patient days for acute care hospitals.



	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Max	946.3	1466.3	1168.4	1685.7	1543.5	1597.0	1166.1	1539.2	1344.4	1577.3	2133.4	1538.1	1654.3	1348.1	1338.0
P75	656.8	620.7	662.9	625.8	607.6	632.6	636.7	630.1	646.2	650.1	644.3	669.1	655.9	654.5	691.7
Median	567.1	545.1	565.5	541.5	523.3	526.8	553.0	550.0	562.5	570.3	571.4	554.4	576.3	577.3	592.6
P25	484.3	485.9	491.7	455.7	464.5	478.3	494.9	487.6	493.9	511.5	505.5	503.2	513.3	510.0	540.2
Min	308.2	337.0	360.5	348.0	323.3	340.7	339.7	353.6	350.8	371.2	370.5	353.5	403.5	389.5	389.5
N	104	104	104	104	105	105	105	105	105	105	105	104	102	102	102

Included units: surgery (210), internal medicine (220), geriatrics (300), pediatrics (230), intensive (270) and non-intensive neonatology (190), maternity (260), infectious disease (250), burn unit (290), intensive care (ICU, 490) and specialized care (610-620-630-640-650-660-690), Max = maximum (with outliers), Min = minimum (with outliers), N = number of included hospitals

Legend boxplot: a. maximum (without outliers, 1.5x interquartile range), b. 75 percentile (P75), c. median, d. mean, e. 25 percentile (P25), f. minimum (without outliers, 1.5x interquartile range)

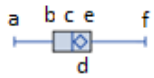


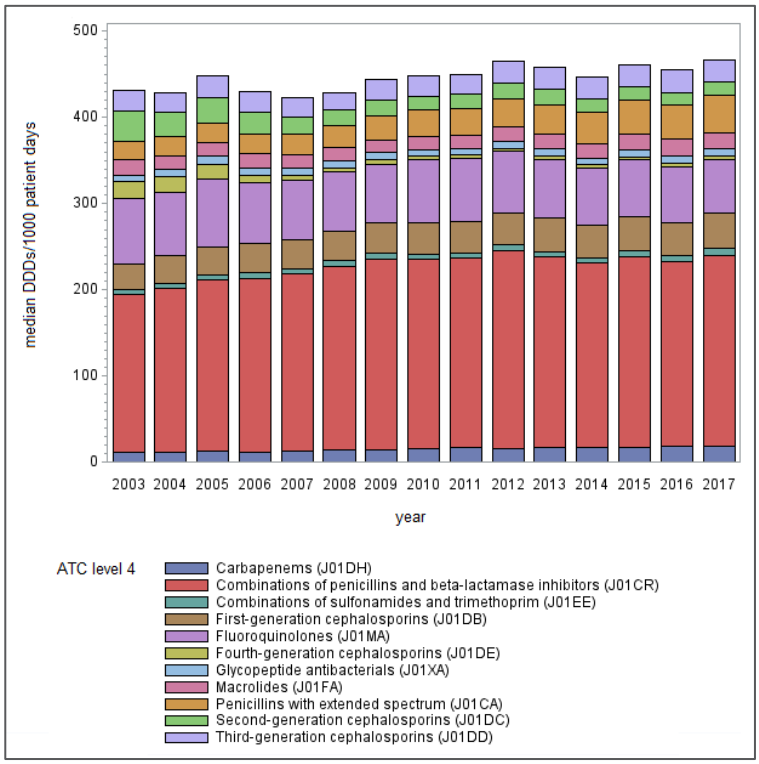
Figure 1: Evolution of the consumption of antibacterials for systemic use (J01) in acute care Belgian hospitals (N=102), expressed in defined daily doses (DDDs)/1000 patient days (2003-2017) – Belgian Hospitals - Surveillance of Antimicrobial Consumption (BeH-SAC)

In 2017 in 62.9% of the total DDDs for J01, the antibiotic agent was administered via a parental route (oral: 36.4%, inhalation: 0.6%, other: 0.1%). Within the antibacterials for systemic use (J01), 'Combinations of penicillins with beta-lactamase inhibitors' (J01CR, 37.3% of the median J01 consumption in 2017) was the most used subclass in 2017 followed by 'Fluoroquinolones' (J01MA, 10.5%). High consumption of fluoroquinolones is mainly explained by high use of ciprofloxacin (J01MA02, median in 2017: 39.4 DDDs/1000 patient days, +23.9% in comparison with 2003, 63.7% of the median J01MA consumption in 2017), moxifloxacin (J01MA14, median in 2017: 13.1 DDDs/1000 patient days, +478.2% in comparison with 2003, 21.1% of the median J01MA consumption in 2017) and levofloxacin (J01MA12, median in 2017: 4.9 DDDs/1000 patient days, -85.5% in comparison with 2003, 7.9% of the median J01MA consumption in 2017).

The evolution (2003-2017) of the median consumption for the main antibiotic subclasses is presented in Figure 2. In this 15-year period, the highest relative decrease in median consumption was detected for 'Fourth-generation cephalosporins' (J01DE, -15.0 DDDs/1000 patient days, -77.3%), 'Second-generation cephalosporins' (J01DC, -19.1 DDDs/1000 patient days, -55.4%) and 'Fluoroquinolones' (J01MA, -14.2 DDDs/1000 patient days, -18.7%). On the other hand, the highest relative increase was found for 'Penicillins with extended spectrum' (J01CA, +21.4 DDDs/1000 patient days, +99.6%), 'Carbapenems' (J01DH, +7.1 DDDs/1000 patient days, +59.2%) and 'First-generation cephalosporins' (J01DB, +10.8 DDDs/1000 patient days, +36.4%).

The top 10 of most used antimicrobial agents (J01 and J02) in 2017 can be found in Figure 3. Amoxicillin in combination with a beta-lactamase inhibitor (J01CR02), cefazolin (J01DB04) and ciprofloxacin (J01MA02) were the most frequently used products. In this top 10, between 2003 and 2017, piperacillin in combination with a beta-lactamase inhibitor (J01CR05, +18.7 DDDs/1000 patient days, +131.3%), amoxicillin (J01CA04, +10.3 DDDs/1000 patient days, +101.2%) and flucloxacillin (J01CF05, +10.8 DDDs/1000 patient days, +91.2%) had the highest relative increase in median consumption. The highest decrease in median consumption was found for cefuroxime (J01DC02, -13.1 DDDs/1000 patient days, -46.0%) and fluconazole (J02AC01, -5.0 DDDs/1000 patient days, -25.6%). The median consumption of amoxicillin in combination with a beta-lactamase inhibitor (J01CR02) increased in this 15-year period (+24.4 DDDs/1000 patient days, +15.1%), but slightly decreased in the last five years (2013-2017, -2.9 DDDs/1000 patient days, -1.5%).

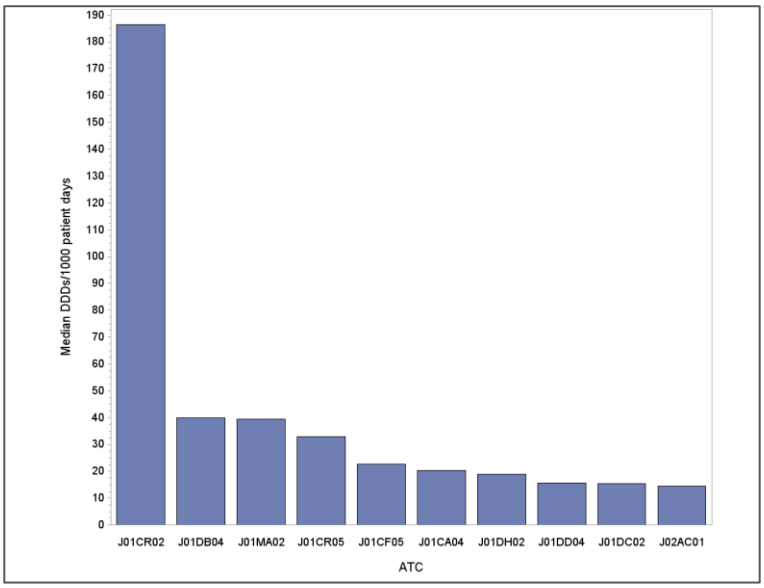
The median percentage of DDDs of broad-spectrum antibiotics among the total DDDs for J01 in 2017 was 27.9% (IQR 23.1%;32.6%). In 2003, this median percentage was 29.9% (IQR 25.6%;33.9%) and in 2016 28.7% (IQR 23.1%;32.6%).
More details on the evolution of the total consumption of broad-spectrum antibiotics in all acute care hospitals in the last five years (2013-2017) can be found in Table 5. In this period, the highest absolute increase in DDDs/1000 patients was found for piperacillin in combination with a beta-lactamase inhibitor (+7.5 DDDs/1000 patient days, % of J01 increased from 4.7% in 2013 to 5.7% in 2017) and carbapenems (+2.6 DDDs/1000 patient days, % of J01 increased from 3.7% in 2013 to 3.9% in 2017). In 2017, the total consumption of broad-spectrum antibiotics was 179.7 DDDs/1000 patient days (% of J01: 29.1%).



ATC-code (level 4)	Name	DDDs/1000 patient days			
		Median in 2017 over all hospitals	% of the median J01 consumption in 2017	% change 2003-2017	% change 2016-2017
J01CR	Combinations of penicillins, incl. beta-lactamase inhibitors	221.24	37.33	20.99	3.56
J01MA	Fluoroquinolones	61.92	10.45	-18.69	-3.88
J01CA	Penicillins with extended spectrum	42.90	7.24	99.63	8.53
J01DB	First-generation cephalosporins	40.44	6.82	36.35	4.04
J01DD	Third-generation cephalosporins	25.38	4.28	4.14	-1.74
J01DH	Carbapenems	19.05	3.21	59.15	-0.73
J01FA	Macrolides	18.51	3.12	4.40	-2.37
J01DC	Second-generation cephalosporins	15.37	2.59	-55.42	2.40
J01XA	Glycopeptide antibacterials	9.30	1.57	25.17	-0.11
J01EE	Combinations of sulfonamides and trimethoprim, incl. derivatives	7.65	1.29	33.04	14.18
J01DE	Fourth-generation cephalosporins	4.40	0.74	-77.28	40.13

ATC = Anatomical Therapeutic Chemical classification; DDD = Defined Daily Dose

Figure 2: Stacked bar plot (top) with the evolution (2003-2017) of the median consumption of the most important antibiotic subclasses (expressed in defined daily doses (DDDs)/1000 patient days) in acute care Belgian hospitals, and corresponding table (bottom) with the median consumption and J01 proportion for 2017 and the evolution of the consumption (2003-2017, 2016-2017) per antibiotic subclass – Belgian Hospitals - Surveillance of Antimicrobial Consumption (BeH-SAC)



J01CR02 = amoxicillin in combination with a beta-lactamase inhibitor, J01DB04 = cefazolin, J01MA02 = ciprofloxacin, J01CR05 = piperacillin in combination with a beta-lactamase inhibitor, J01CF05 = flucloxacillin, J01CA04 = amoxicillin, J01DH02 = meropenem, J01DD04 = ceftriaxone, J01DC02 = cefuroxime, J02AC01 = fluconazole

Figure 3: The top 10 of most used antimicrobial agents (J01 and J02) in acute care Belgian hospitals in 2017, expressed in defined daily doses (DDDs)/1000 patient days – Belgian Hospitals - Surveillance of Antimicrobial Consumption (BeH-SAC)

Table 5: Evolution (2013-2017) of the total consumption of antibacterials for systemic use (J01) and broad-spectrum antibiotics in all acute care Belgian hospitals, expressed in defined daily doses (DDDs)/1000 patient days and percentage of J01 consumption – Belgian Hospitals - Surveillance of Antimicrobial Consumption (BeH-SAC)

Total consumption in all acute care hospitals	2013	2014	2015	2016	2017
All antibacterials for systemic use (J01)					
DDDs/1000 patient days	588.9	586.9	598.9	605.4	618.3
Third-generation cephalosporins (J01DD)					
DDDs/1000 patient days	28.5	27.5	29.9	29.5	30.4
% of J01	4.8	4.7	5.0	4.9	4.9
Fourth-generation cephalosporins (J01DE)					
DDDs/1000 patient days	8.1	8.0	8.0	7.2	7.6
% of J01	1.4	1.4	1.4	1.2	1.3
Monobactams (J01DF)					
DDDs/1000 patient days	0.7	0.8	0.7	0.7	0.8
% of J01	0.1	0.1	0.1	0.1	0.1
Carbapenems (J01DH)					
DDDs/1000 patient days	21.7	23.6	24.4	24.3	24.3
% of J01	3.7	4.0	4.1	4.0	3.9
Fluoroquinolones (J01MA)					
DDDs/1000 patient days	68.1	67.4	68.1	66.4	64.3
% of J01	11.6	11.5	11.4	11.0	10.4
Glycopeptide antibacterials (J01XA)					
DDDs/1000 patient days	12.0	12.4	12.8	13.1	13.4
% of J01	2.0	2.1	2.1	2.2	2.2
Polymyxins (J01XB)					
DDDs/1000 patient days	2.5	2.6	2.3	2.8	2.6
% of J01	0.4	0.4	0.4	0.5	0.4
Piperacillin and enzyme inhibitor (J01CR05)					
DDDs/1000 patient days	27.7	29.5	31.1	33.3	35.2
% of J01	4.7	5.0	5.3	5.5	5.7
Linezolid (J01XX08)					
DDDs/1000 patient days	1.2	1.1	1.1	1.1	1.1
% of J01	0.2	0.2	0.2	0.2	0.2
Daptomycin (J01XX09)					
DDDs/1000 patient days	0	0	0	0	0
% of J01	0	0	0	0	0
Tedizolid (J01XX11)					
DDDs/1000 patient days	0	0	0	0	0
% of J01	0	0	0	0	0
All broad-spectrum antibiotics					
DDDs/1000 patient days	170.4	173.0	178.4	178.5	179.7
% of J01	28.9	29.5	29.8	29.5	29.1

Antibiotic consumption per hospital unit

The median antibiotic consumption in 2017 in ICU was 1212.6 DDDs/1000 patient days (+14.5 DDDs/1000 patient days (+1.21%) in comparison with 2003, -40.7 DDDs/1000 patient days (-3.24%) in comparison with 2016). More details about the consumption of J01 in 2017 in other hospital units are available in Table 6.

Table 6: Median consumption of antibacterials for systemic use (J01) in 2017 per hospital unit (acute care Belgian hospitals), expressed in defined daily doses (DDDs)/1000 patient days – Belgian Hospitals - Surveillance of Antimicrobial Consumption (BeH-SAC)

	Median consumption in DDDs/1000 patient days in 2017	Number of hospitals included
Intensive care (ICU)	1212.6	101
Burn unit	798.3	5
Paediatrics*	709.5*	93
Internal medicine (including infectious diseases)	682.7	102
Surgery	650.3	102
Geriatrics	537.1	98
Specialized care: cardio-pulmonary	318.2	17
Maternity	240.3	97
Specialized care: chronic – polypathology	222.3	19
Specialized care: locomotive	176.8	66
Specialized care: neurological	155.1	24
Specialized care: psycho-geriatrics	117.9	16
Neonatology, intensive care*	114.1*	19
Specialized care: chronic - palliative care	105.5	45
Neonatology, non-intensive*	50.0*	80
Overall consumption in the hospital	592.6	102
Consumption in acute non-paediatric units (ICU excluded)**	618.6	102

* DDDs have been developed for adults (70 kg) so interpretation for new-borns and children is therefore not straightforward.
** Included units: surgery, internal medicine, infectious diseases, maternity, burn unit and geriatrics. ICU was excluded in total, because ICU Paediatrics cannot be separately excluded.

In acute non-paediatric units (ICU excluded), the median antibiotic consumption in 2017 was 618.6 DDDs/1000 patient days (+66.6 DDDs/1000 patient days (+12.1%) in comparison with 2003, +23.4 DDDs/1000 patient days (+3.9%) in comparison with 2016). The evolution of the antibiotic consumption between 2003 and 2017 in acute non-paediatric units is presented in Figure 4.

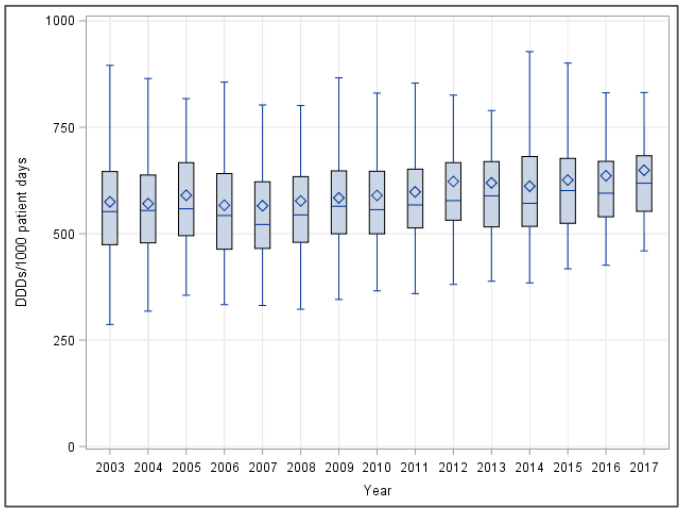


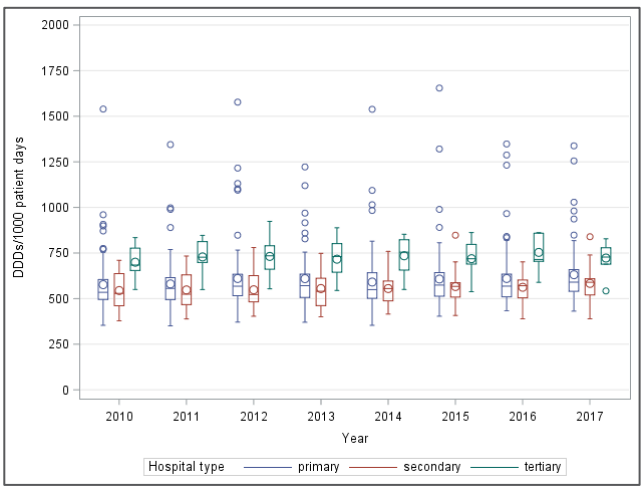
Figure 4: Evolution of the consumption of antibacterials for systemic use (J01) in acute non-paediatric units (intensive care excluded) in acute care Belgian hospitals (N=102), expressed in defined daily doses (DDDs)/1000 patient days (2003-2017) – Belgian Hospitals - Surveillance of Antimicrobial Consumption (BeH-SAC)

Antibiotic consumption per type and size of hospitals

The antibiotic consumption was higher in tertiary hospitals (N=7, median in 2017: 727.8 DDDs/1000 patient days) than in other hospitals. In Table 7, the median antibiotic consumption in 2017 is displayed per type and per size of acute care Belgian hospitals. The evolution (2010-2017) of antibiotic consumption per type of hospital (with outliers) is presented in Figure 5.

Table 7: Median consumption of antibacterials for systemic use (J01) in 2017 per type and size (acute care Belgian hospitals), expressed in defined daily doses (DDDs)/1000 patient days – Belgian Hospitals - Surveillance of Antimicrobial Consumption (BeH-SAC)

	Median consumption in DDDs/1000 patient days in 2017	Number of hospitals included
Per type		
Primary	590.2	77
Secondary	589.6	17
Tertiary	727.8	7
Per size		
Large (>600 beds)	589.6	27
Medium (400-600 beds)	588.5	26
Small (<400 beds)	598.2	49



Included units: surgery (210), internal medicine (220), geriatrics (300), pediatrics (230), intensive (270) and non-intensive neonatology (190), maternity (260), infectious disease (250), burn unit (290), intensive care (ICU, 490) and specialized care (610-620-630-640-650-660-690)

Legend boxplot: a. maximum (without outliers, 1.5x interquartile range), b. 75 percentile (P75), c. median, d. mean, e. 25 percentile (P25), f. minimum (without outliers, 1.5x interquartile range)
Outliers included in the graph

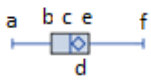
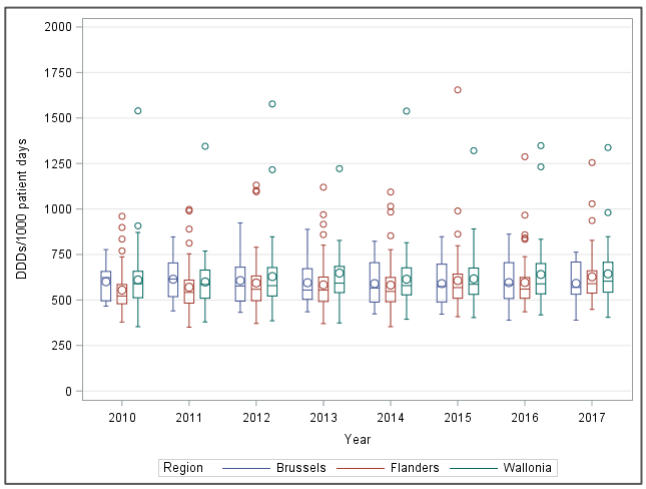


Figure 5: Evolution of the consumption of antibacterials for systemic use (J01) in acute care Belgian hospitals stratified by type of hospital (primary=blue, secondary=red, tertiary=green), expressed in defined daily doses (DDDs)/1000 patient days (2010-2017) – Belgian Hospitals - Surveillance of Antimicrobial Consumption (BeH-SAC)

Antibiotic consumption per region

The median antibiotic consumption in DDDs/1000 patient days in 2017 was 569.3, 589.9 and 603.4 in acute care hospitals in Brussels (N=12), Flanders (N=54) and Wallonia (N=36), respectively. Figure 6 presents the evolution (2010-2017) of the antibiotic consumption per region (with outliers) of acute care hospitals.



Included units: surgery (210), internal medicine (220), geriatrics (300), pediatrics (230), intensive (270) and non-intensive neonatology (190), maternity (260), infectious disease (250), burn unit (290), intensive care (ICU, 490) and specialized care (610-620-630-640-650-660-690)

Legend boxplot: a. maximum (without outliers, 1.5x interquartile range), b. 75 percentile (P75), c. median, d. mean, e. 25 percentile (P25), f. minimum (without outliers, 1.5x interquartile range)
Outliers included in the graph

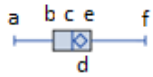
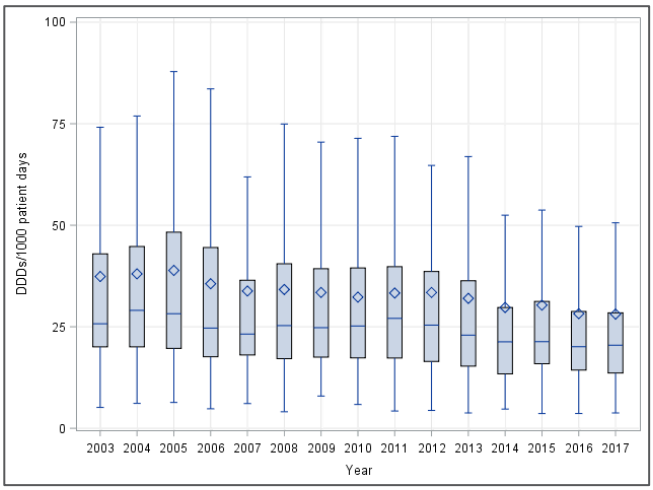


Figure 6: Evolution of the consumption of antibacterials for systemic use (J01) in acute care Belgian hospitals stratified by region of hospital (Brussels=blue, Flanders=red, Wallonia=green), expressed in defined daily doses (DDDs)/1000 patient days (2010-2017) – Belgian Hospitals - Surveillance of Antimicrobial Consumption (BeH-SAC)

Overall consumption (hospital-wide) of other antimicrobial agents

Finally, the median consumption of antifungals and antimycotics for systemic use (D01AB and J02) in 2017 was 20.5 DDDs/1000 patient days and decreased over time (decrease of 5.2 DDDs/1000 patient days (-20.2%) in comparison with 2003, increase of 0.4 DDDs/1000 patient days (+2.0%) in comparison with 2016). The evolution (2003-2017) of this consumption is displayed in Figure 7. The median consumption in 2017 in acute care hospitals of other antimicrobial subclasses are presented in Table 8.



Included units: surgery (210), internal medicine (220), geriatrics (300), pediatrics (230), intensive (270) and non-intensive neonatology (190), maternity (260), infectious disease (250), burn unit (290), intensive care (ICU, 490) and specialized care (610-620-630-640-650-660-690)

Legend boxplot: a. maximum (without outliers, 1.5x interquartile range), b. 75 percentile (P75), c. median, d. mean, e. 25 percentile (P25), f. minimum (without outliers, 1.5x interquartile range)

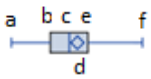


Figure 7: Evolution of the consumption of antifungals and antimycotics for systemic use (D01AB and J02) *in acute care Belgian hospitals (N=102), expressed in defined daily doses (DDDs)/1000 patient days (2003-2017) – Belgian Hospitals - Surveillance of Antimicrobial Consumption (BeH-SAC)*

Table 8: Overview of the median consumption of other antimicrobial subclasses (ATC-level 2-3-4) included in the BeH-SAC surveillance in 2017 – Belgian Hospitals - Surveillance of Antimicrobial Consumption (BeH-SAC)

ATC-code (level 2-3-4)	Name	Median DDDs/1000 patient days in 2017	% change 2003-2017	% change 2016-2017
A07AA	Intestinal antibiotics	7.40	176.12	2.35
D01BA	Antifungals for systemic use	0.51	-46.32	-17.74
J02	Antimycotics for systemic use	19.74	-19.79	0.92
J02AC	Triazole derivates	18.11	-23.42	2.14
J02AX	Other antimycotics for systemic use (echinocandins)	0.93	128.57	-2.04
P01AB	Agents against amoebiases and other protozoal diseases: nitroimidazole derivatives	5.24	12.69	-0.38
J04A	Drugs for treatment of tuberculosis	7.83	-5.55	6.97
J05	Antivirals for systemic use	6.39	NA*	27.80

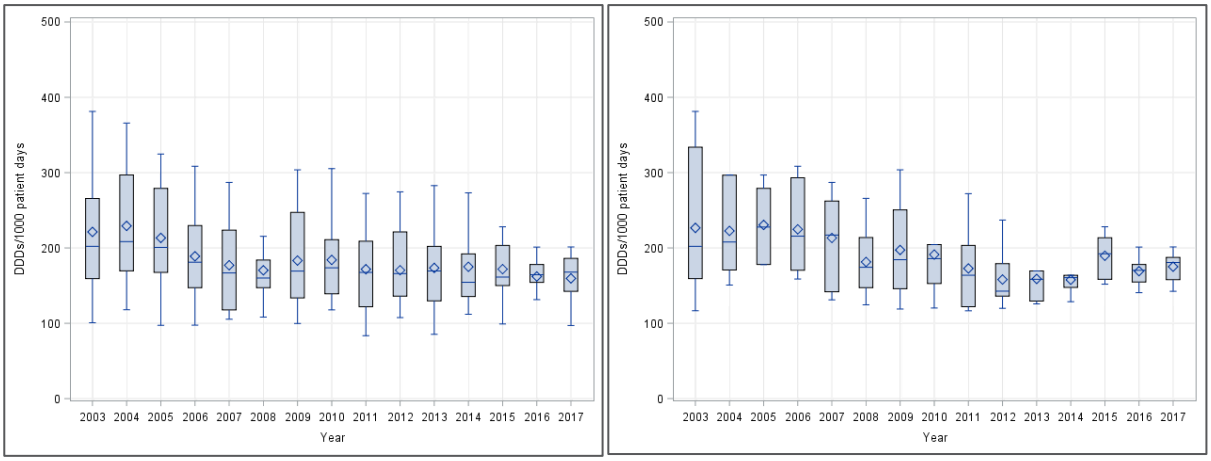
* J05 only available starting from 2015
ATC = Anatomical Therapeutic Chemical classification; DDD = Defined Daily Dose

Chronic care hospitals

Overall antibiotic consumption (hospital-wide)

The median consumption of antibacterials for systemic use (J01) in 2017 in all chronic care Belgian hospitals (N=13) was 168.0 DDDs/1000 patient days (decrease of 34.2 DDDs/1000 patient days (-16.9%) in comparison with 2003, increase of 3.5 DDDs/1000 patient days (+2.1%) in comparison with 2016). In large chronic care hospitals (≥150 beds), the median antibiotic consumption was 180.7 DDDs/1000 patient days (decrease of 21.5 DDDs/1000 patient days (-10.6%) in comparison with 2003, increase of 10.4 DDDs/1000 patient days (+6.1%) in comparison with 2016).

In Figure 8, the evolution (2003-2017) of antibiotic consumption is displayed for all chronic care hospitals (8A) and for large chronic hospitals with ≥150 beds (8B).



A. All chronic care hospitals (N=13) B. Chronic care hospitals with ≥150 beds (N=6)

Included units: geriatrics (300) and specialized care (610-620-630-640-650-660-690)

Legend boxplot: a. maximum (without outliers, 1.5x interquartile range), b. 75 percentile (P75), c. median, d. mean, e. 25 percentile (P25), f. minimum (without outliers, 1.5x interquartile range)

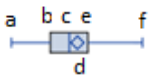
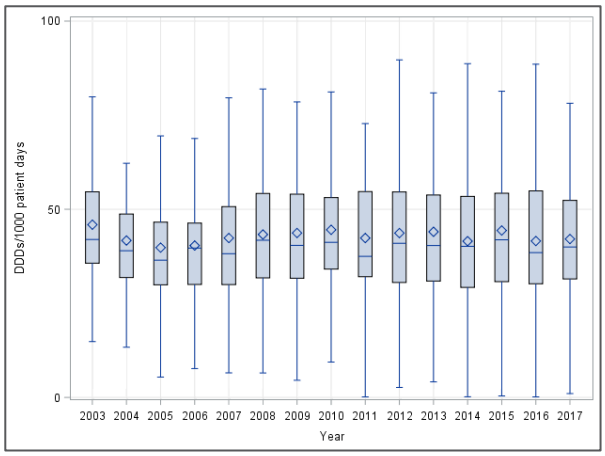


Figure 8: Evolution of the consumption of antibacterials for systemic use (J01) in chronic care Belgian hospitals, expressed in defined daily doses (DDDs)/1000 patient days (2003-2017) – Belgian Hospitals - Surveillance of Antimicrobial Consumption (BeH-SAC)

Psychiatric hospitals

Overall antibiotic consumption (hospital-wide)

In Belgian psychiatric hospitals (N=55), the median consumption of antibacterials for systemic use (J01) in 2017 was 40.0 DDDs/1000 patient days (decrease of 2.0 DDDs/1000 patient days (-4.8%) in comparison with 2003, increase of 1.5 DDDs/1000 patient days (+3.9%) in comparison with 2016). The evolution (2003-2017) of antibiotic consumption in psychiatric hospitals is presented in Figure 9.



Included units: neuropsychiatry pediatrics (340-350-360), neuropsychiatry (370-380-390), psychiatry (410-420-430), psychiatry ICU (480) and specialized care (psycho-geriatrics, 660)

Legend boxplot: a. maximum (without outliers, 1.5x interquartile range), b. 75 percentile (P75), c. median, d. mean, e. 25 percentile (P25), f. minimum (without outliers, 1.5x interquartile range)

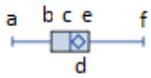


Figure 9: Evolution of the consumption of antibacterials for systemic use (J01) in psychiatric Belgian hospitals, expressed in defined daily doses (DDDs)/1000 patient days (2003-2017) – Belgian Hospitals - Surveillance of Antimicrobial Consumption (BeH-SAC)

COMPARISON WITH THE OLD METHODOLOGY

A comparison was made between the results of ABUH and BeH-SAC for the overlapping hospitals (N=98) and years (2007-2014) in both databases. Five hospitals were excluded because no identity link could be confirmed between the former hospital code in ABUH and the current NIHDI-code in BeH-SAC. In Table 9, the annual median antibiotic (J01) consumption rates are compared for the overall hospital use (9A) and for ICU (9B). In Table 10, the medians of the absolute differences per hospital and per year are presented. Overall, a median absolute difference in antibiotic consumption (J01) of 3.09% in DDDs/1000 patient days (IQR 1.28;8.02) and a median absolute difference of 3.94% in DDDs/1000 admissions (IQR 1.66;13.24) was found.

Table 9: Comparison of the annual median antibiotic (J01) consumption rates in Belgian surveillance systems ABUH (Antibiotic Use in Hospitals) versus BeH-SAC (Belgian Hospitals – Surveillance of Antimicrobial Consumption) for the overlapping hospitals and years (2007-2014), in the participating hospitals overall (9A) and intensive care units (9B)

9A. Overall hospital use

Year	Number of hospitals	Median J01 consumption in DDDs/1000 patient days			Median J01 consumption in DDDs/1000 admissions		
		ABUH	BeH-SAC	% absolute difference	ABUH	BeH-SAC	% absolute difference
2007	52	520.4	515.9	0.86%	3884.9		
2008	93	523.5	520.2	0.63%	3848.9	4074.5	5.86%
2009	94	546.4	546.1	0.05%	3903.7	4069.6	4.24%
2010	95	531.2	531.9	0.13%	3963.9	4102.4	3.49%
2011	94	554.1	556.0	0.34%	4000.7	4084.7	2.10%
2012	90	557.9	563.8	1.06%	4018.6	4159.6	3.51%
2013	81	546.1	571.2	4.60%	3752.1	3955.8	5.43%
2014	22	560.7	553.6	1.27%	3968.4	3920.4	1.21%

* Consumption in DDDs/1000 admissions only available from 2008 in BeH-SAC

9B. Intensive care unit (ICU)

Year	Number of hospitals	Median J01 consumption in DDDs/1000 patient days		
		ABUH	BeH-SAC	% absolute difference
2007	36	1197.3	1226.9	2.47
2008	57	1216.1	1268.7	4.33
2009	62	1253.4	1290.6	2.97
2010	63	1226.7	1228.8	0.17
2011	63	1245.5	1240.0	0.44
2012	60	1201.6	1214.0	1.03
2013	61	1241.7	1251.1	0.76
2014	18	1058.0	1134.5	7.23

* Consumption in ICU is only expressed in DDDs/1000 patient days, because misclassification bias can occur in the number of admissions per unit

Table 10: Median differences and outliers in the comparison of the antibiotic (J01) consumption rates in ABUH (Antibiotic Use in Hospitals) and BeH-SAC (Belgian Hospitals – Surveillance of Antimicrobial Consumption) per hospital (and per year, hospital type, size and region), for the overlapping hospitals and years (2007-2014)

	Number of hospitals	J01 consumption in DDDs/1000 patient days		J01 consumption in DDDs/1000 admissions	
		Median % absolute difference [IQR] between ABUH and BeH-SAC	Number of hospitals with % difference >50%	Median % absolute difference [IQR] between ABUH and BeH-SAC	Number of hospitals with % difference >50%
All hospitals and all years	98	3.09 [1.28;8.02]	13	3.94 [1.66;13.24]	15
All ICU-wards and all years	73	6.74 [2.14;20.58]	17		
Per year					
2007	52	2.85 [0.62;11.40]	0		
2008	93	2.82 [1.15;7.18]	3	3.85 [1.54;14.31]	5
2009	94	3.20 [1.45;6.95]	3	3.39 [1.57;13.06]	4
2010	95	3.35 [1.60;9.46]	3	5.16 [1.24;14.25]	3
2011	94	2.85 [0.95;8.43]	2	5.78 [1.92;12.14]	2
2012	90	2.53 [1.30;6.67]	4	3.53 [1.82;11.49]	4
2013	81	4.14 [2.05;12.23]	6	4.61 [2.38;15.14]	8
2014	22	4.04 [0.93;6.51]	0	3.73 [1.51;6.57]	0
Per type of hospital					
Primary	72	2.80 [1.21;7.20]	11	3.81 [1.57;12.52]	12
Secondary	15	4.17 [1.76;10.77]	1	5.25 [2.01;16.33]	0
Tertiary	7	3.89 [0.80;7.91]	0	2.91 [1.16;6.61]	2
Specialised	4	14.94 [1.76;24.74]	1	20.86 [11.61;30.15]	1
Per size of hospital					
Large (>600 beds)	23	3.33 [1.27;8.54]	1	3.82 [1.53;13.40]	4
Medium (400-600 beds)	25	2.55 [1.08;4.93]	1	3.29 [1.73;9.25]	1
Small (<400 beds)	50	3.35 [1.34;9.86]	11	5.16 [1.70;14.32]	10
Per region					
Brussels	11	4.45 [2.36;7.96]	1	5.43 [2.01;9.30]	1
Flanders	54	2.22 [0.91;5.99]	6	3.18 [1.52;10.36]	7
Wallonia	33	4.02 [1.90;11.98]	6	8.59 [2.07;16.96]	7

* Consumption in DDDs/1000 admissions only available from 2008 in BeH-SAC
** Consumption in ICU is only expressed in DDDs/1000 patient days, because misclassification bias can occur in the number of admissions per unit
IQR: interquartile range

In 16 hospitals, an absolute difference in the overall antibiotic consumption rate between ABUH and BeH-SAC of >50% was detected (for one or more years, in DDDs/1000 patient days and/or DDDs/1000 admissions). An in-depth analysis of these outliers showed that the majority (10/16) was caused by variation in the ABUH data over the different years (in the numerator data: N=6; in the denominator data: N=4). For the other six outliers, no clear reason for the large difference between ABUH and BeH-SAC could be identified.

Figure 10 presents the evolution of the antibiotic consumption in ABUH and BeH-SAC for the overlapping hospitals and years. Trend-analysis revealed a significant increasing trend in the antibiotic consumption in DDDs/1000 patient days in both ABUH (p=0.036, Kendall Tau b: 0.060) and BeH-SAC (p=0.001, Kendall Tau b: 0.092). For the antibiotic consumption in DDDs/1000 admissions, no significant trend was found in ABUH (p=0.272, Kendall Tau b: -0.033) or BeH-SAC (p=0.281, Kendall Tau b: -0.032).

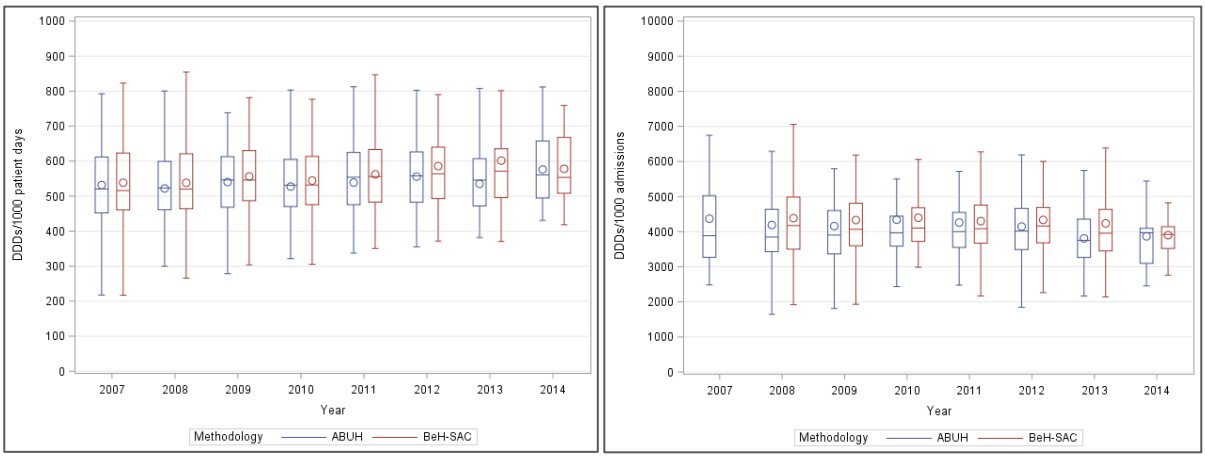


Figure 10: Evolution of the antibiotic consumption in ABUH (Antibiotic Use in Hospitals) and BeH-SAC (Belgian Hospitals – Surveillance of Antimicrobial Consumption) for the overlapping hospitals and years (2007-2014), in DDDs/1000 patient days (left) and in DDDs/1000 admissions (right)

* Consumption in DDDs/1000 admissions only available from 2008 in BeH-SAC

REPORTS ON HEALTHSTAT

Public reports of BeH-SAC with **national and regional results** are freely available on: https://www.healthstat.be/

Three types of reports are provided:

- An evolution graph presenting the variation in the antimicrobial consumption over all hospitals, displayed with a boxplot.
- A line graph presenting the time evolution of the consumption of a specific antimicrobial product.
- A bar plot of the median consumption of the top 10 most used antimicrobial products (J01 and J02) in all hospitals.

For each report, the following parameters can be chosen interactively:

- Period from/to
- Level of stratification (all Belgian hospitals, per region (Flanders, Wallonia, Brussels), per kind (acute/chronic/psychiatric), type (primary/secondary/tertiary/specialized), size (large: >600 beds, medium: 400-600 beds, small: <400 beds))
- Unit(s)
  Attention: In case the option 'all units' is selected, psychiatric wards and surgical day hospitalizations are also included in the analyses by default. To exclude these wards, one can select the option 'all units without psychiatry and day hospitalizations' (190, 210, 220, 230, 250, 260, 270, 290, 300, 490, 610-690) or select a specific list of units.
- ATC-code(s)
- Denominator (patient days, admissions or no denominator to see the total number of DDDs)
  Attention: It is recommended to use 'patient days' as a denominator for analyses per unit, since misclassification can occur in the number of admissions per unit (when patients stay at different units during one hospital stay).

The same reports are also available **per hospital**, with detailed results for the own hospital and the possibility to benchmark with similar hospitals. All hospitals can request access to these reports on Healthstat. For more information about this access, please consult the NSIH-website:
http://www.nsih.be/surv_gm/download_nl.asp - http://www.nsih.be/surv_gm/download_fr.asp

In Table 11 and 12, the current use of the BeH-SAC reports on Healthstat is demonstrated.

Table 11: Number of registered hospitals and users in Healthstat for the BeH-SAC surveillance (Belgian Hospitals - Surveillance of Antimicrobial Consumption), status on 24/5/2018 and 28/8/2018

Status on	Number of registered hospitals	Number of registered users	Number of users that at least opened one BeH-SAC report on Healthstat
24/5/2018	25	51	21
28/8/2018	43	91	43

Table 12: Number of views on Healthstat for the national and hospital reports of the BeH-SAC surveillance (Belgian Hospitals - Surveillance of Antimicrobial Consumption), status on 28/8/2018

Reports	Number of views
National reports (available starting from 2/7/2018)	
Graph with boxplots	130
Line graph with time evolution	99
Bar plot with top 10 most used products	62
Hospitals reports (available starting from 26/4/2018)	
Graph with boxplots	524
Line graph with time evolution	543
Bar plot with top 10 most used products	278

DISCUSSION

COMPARISON WITH THE OLD METHODOLOGY

- A comparison was made between the results of BeH-SAC (reimbursement data) and the old methodology (ABUH, self-reported data by hospitals) for overlapping hospitals and years (2007-2014). Overall, a median absolute difference in antibiotic consumption (J01) of 3.09% in DDDs/1000 patient days and 3.94% in DDDs/1000 admissions was found. The absolute differences in the annual median consumptions in DDDs/1000 patient days ranged from 0.05% to 4.60%, and in DDDs/1000 admissions from 1.21% to 5.86%. The same trends in the evolution of antibiotic consumption were detected in BeH-SAC and ABUH.

- Higher difference for the consumption in DDDs/1000 admissions was expected, because the calculation of the number admissions is more susceptible to bias (e.g. avoidance of doubles in BeH-SAC by collecting separate data from NIHDI per year and per trimester). When analyses are performed for specific hospital units (e.g. ICU), only the consumption in DDDs/1000 patient days should be considered reliable due to the possible misclassification bias in the number of admissions per unit (e.g. patients who stay in different units during one hospital admission).

- Outliers (>50% difference, 16 hospitals) were mainly due to variation in the ABUH data. These results confirm the known heterogeneity in the data collection of ABUH, and the more uniform data collection in BeH-SAC resulting in a reliable benchmarking between hospitals.

MAIN RESULTS

- The median antibacterial consumption in acute care Belgian hospitals remained similar to the previous years with a median consumption of 592.6 DDDs/1000 patient days in 2017 and 3890.3 DDDs/1000 admissions in 2016. In the 15-year period (2003-2017), there was a small increase in DDDs/1000 patient days (+25.5 DDDs/1000 patient days, +4.5%). In DDDs/1000 admissions, between 2008 and 2016, a small decrease was detected (-284.2 DDDs/1000 admissions, -6.8%). The evolution towards shorter hospital stay in acute care Belgian hospitals might explain this small increase in DDDs/1000 patient days and small decrease in DDDs/1000 admissions. This was also reported by other authors (10,11) and in other European countries (12,13).

- The consumption of antibiotics was the highest in tertiary (university) hospitals (727.8 DDDs/1000 patient days) and in the ICU department (1212.6 DDDs/1000 patient days).

- The boxplots indicate that there is a high variation between hospitals, also within hospitals of the same type (tertiary/secondary/primary), and therefore room for improvement (e.g. see outliers in Figure 5). Outliers should be investigated further in detail.

- Amoxicillin in combination with a beta-lactamase inhibitor remained the most prescribed antimicrobial agent, followed by cefazolin and ciprofloxacin. The high use of broad-spectrum antibiotics (median % of J01: 28%, total consumption in 2017: 179.7 DDDs/1000 patient days), especially fluoroquinolones (ciprofloxacin and moxifloxacin), should be a target for improvement. In the group of broad-spectrum antibiotics, the highest absolute increase in total consumption in the last five years (2013-2017) was detected for piperacillin in

combination with a beta-lactamase inhibitor (+7.5 DDDs/1000 patient days) and carbapenems (+2.6 DDDs/1000 patient days).

STRENGTHS

- BeH-SAC provides an extended (2003-2016, approximately 99% of the Belgian population) and detailed (per hospital unit, per trimester) database of antimicrobial consumption data to investigate the evolution through time and to provide benchmarking between hospitals.
- There is a lower workload for the hospitals, a decreased variation in data collection and a new reporting system enabling detailed stratifications in comparison with the old methodology (ABUH).
- Different indicators (DDDs/1000 patient days and DDDs/1000 admissions) are used to express antimicrobial consumption.

LIMITATIONS

- DDDs are not always in line with the actual doses used in Belgian hospitals. Moreover, using DDDs in paediatrics or for patients with special dose adjustments (e.g. kidney failure) can lead to over- or underestimations of the dosing.
- Adaptations in the reimbursement data (additional data or corrections) can still occur until two years after the first data delivery, so the data of 2015-2017 remain preliminary.
- The available hospital units are based on an administrative classification of NIHDI. This classification currently not allows feedback to specific prescribers (e.g. pneumology, cardiology, hemato-oncology and other units are all combined in ‘internal medicine’). It is mandatory that besides the national surveillance system BeH-SAC, hospitals also maintain a local surveillance system of antimicrobial consumption with more detailed data.

FUTURE PERSPECTIVES

- The methodology of BeH-SAC can further be improved with more stratified data per diagnosis, by coupling consumption data with diagnoses registered in the minimal hospital data.
- A shorter delay of the data between consumption and reporting (towards real-time feedback) would improve the usability of the results, in particular during outbreaks of multidrug resistant organisms and *Clostridium difficile*.
- Use of a second indicator based on the actual doses used in Belgian hospitals and adjusted to paediatric formulations (DDA: Daily Doses Administered) is considered for the future.
- The data of BeH-SAC can be useful to investigate the impact of antibiotic stewardship initiatives on hospital consumption or to study the link between antimicrobial resistance and consumption.
- Hospitals will be further stimulated and assisted to use the feedback reports on Healthstat.be for the follow-up and optimization of the antimicrobial consumption in their hospital (e.g. organization of a workshop).

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CONTACT
Eline Vandael • eline.vandael@sciensano.be • T +32 2 642 50 26

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Sciensano • Rue Juliette Wytsmanstraat 14 • 1050 Brussels • Belgium • T + 32 2 642 51 11 • T press + 32 2 642 54 20 • info@sciensano.be • **www.sciensano.be**

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Dr. M. Sneyers, Managing director • Rue Juliette Wytsmanstraat 14 • 1050 Brussels • Belgium • D/2018/14.440/27