# How to measure hospital antibiotic consumption: comparison of two methods from data surveillance in France

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# How to measure hospital antibiotic consumption: comparison of two methods from data surveillance in France

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**Background:** Antibiotic use (ABU) surveillance in healthcare facilities (HCFs) is essential to guide stewardship. Two methods are recommended: antibiotic consumption (ABC), expressed as the number of DDD/1000 patient-days; and prevalence of antibiotic prescription (ABP) measured through point prevalence surveys. However, no evidence is provided about whether they lead to similar conclusions.

**Objectives:** To compare ABC and ABP regarding HCF ranking and their ability to identify outliers.

**Methods:** The comparison was made using 2012 national databases from the antibiotic surveillance network and prevalence study. HCF rankings according to each method were compared with Spearman's correlation coefficient. Analyses included the ABU from entire HCFs as well as according to type, clinical ward and by antibiotic class and specific molecule.

**Results:** A total of 1076 HCFs were included. HCF rankings were strongly correlated in the whole cohort. The correlation was stronger for HCFs with a higher number of beds or with a low or moderate proportion of acute care beds. ABU correlation between ABC or ABP was globally moderate or weak in specific wards. Furthermore, the two methods did not identify the same outliers, whichever HCF characteristics were analysed. Correlation between HCF ranking varied according to the antibiotic class.

**Conclusions:** Both methods ranked HCFs similarly overall according to ABC or ABP; however, major differences were observed in ranking of clinical wards, antibiotic classes and detection of outliers. ABC and ABP are two markers of ABU that could be used as two complementary approaches to identify targets for improvement.

## Introduction

Antibiotic resistance is spreading all around the world and represents a threat for global health.[1] Antibiotic misuse is a known key determinant of antibiotic resistance development.[2,3] Thus, antibiotic stewardship aims to improve antibiotic prescription management and reduce unnecessary or excessive antibiotic use.[4] Antibiotic use (ABU) surveillance networks help healthcare facilities (HCFs) to produce appropriate data to compare themselves with others and to monitor trends, in order to implement targeted antibiotic stewardship. In addition, the surveillance networks allow the identification of HCFs with the highest ABU, so-called outlier HCFs.

Antibiotic consumption (ABC) is generally measured as the number of DDD/1000 patient-days (PD), as recommended by the WHO using the Anatomical Therapeutic Chemical (ATC) index.[5] In addition, the European Surveillance of Antimicrobial Consumption (ESAC) programme has implemented point prevalence surveys (PPSs) as an alternative method.[6–8] PPSs measure ABU as antibiotic prevalence (ABP), defined as the prevalence of inpatients receiving

at least one antibiotic agent on the day of the survey. Those two methods, ABC and ABP, are proposed to measure ABU. However, to the best of our knowledge, these two methods have never been evaluated in relation to each other, in terms of ranking HCFs according to their ABU, or to define which HCFs may be identified as ABU outliers.

In France, a national antibiotic consumption surveillance, called ATB-Raisin, has been implemented in all voluntary HCFs since 2007, providing ABC data every year.[9] Also, a national hospital-acquired infection and ABU PPS is conducted every 5 years in almost every HCF in France, providing ABP data.[10] The objective of this study was to compare ABC and ABP for HCF ranking as well as for the identification of outliers using the 2012 hospital data from ATB-Raisin and the national prevalence survey.

## Methods

### Data source

ATB-Raisin, the French hospital ABC surveillance network, has been implemented since 2007 and is described elsewhere.[11] It aims to collect ABC data and to describe patterns of consumption, in order to identify room for improvement. Participation is voluntary and requires HCFs to provide structural elements (hospital type, number of beds, number of PDs, type of activities, etc.) in addition to data about ABC for the whole HCF and by type of ward (i.e. medicine, surgery, ICU, gynaecology, psychiatry, rehabilitation, long-term care). ABC from 1 January to 31 December was retrospectively collected. ABC data were expressed as a distribution (median, IQR). Tukey box plots were used to show selected percentiles and outside values and for comparing distribution.[12,13] ABC outliers were defined as follows: an HCF where ABC was greater than 1.5 times the IQR above the upper quartile [meaning higher than $p75 + 1.5 \times (p75 - p25)$, where p75 and p25 are the 75th and the 25th percentiles of ABC distribution, respectively] was called a 'superior outlier'; an HCF where ABC was lower than 1.5 times the IQR below the lower quartile [meaning lower than $p25 - 1.5 \times (p75 - p25)$] was called an 'inferior outlier'. These HCFs whose consumption was significantly different from that of the other HCFs were individually warned about their status to help them implement antibiotic stewardship measures.

A national hospital-acquired infection and ABU prevalence study is conducted every 5 years in France. The last PPS proposed to every French HCF was conducted in 2012 (14 May to 29 June).[14] In addition to the same structural data as in ATB-Raisin, HCFs had to provide data about every inpatient present before 8 am on the day of the survey. All inpatient units were considered, including acute care, rehabilitation care and long-term care units. All antibiotics prescribed on this day were recorded. ABP outliers were identified with the same definition as the ATB-Raisin survey.

The daytime hospitalization sector and nursing homes were not included in either survey. Data for the year 2012, the last one with available data for both the PPS (for ABP) and ATB-Raisin surveillance network (for ABC), were included in this study.[14]

### Quantification of antimicrobial source

In the ATB-Raisin network, ABC was expressed as the number of DDD/1000 PD, according to the WHO/ATC 2012 index, the DDD being the assumed average maintenance dose per day for a drug used for its main indication in a 70 kg adult. In the PPS, results were expressed using prevalence (ABP), which represented the proportion of patients receiving at least one antimicrobial agent among the totality of the inpatients (prevalence of treated patients). HCFs that had included fewer than 20 inpatients in the PPS were excluded from the study.

### Selection of antibiotics

ABU was analysed according to the therapeutic categories defined in the WHO/ATC 2012 index.

Some selected molecules frequently used or considered as critical for antibiotic resistance selection were tested on their own.

### Statistical analysis

HCFs were ranked according to their ABU expressed as ABC on one hand and as ABP on the other hand, for overall ABU and per selected drugs. Each HCF had a unique identifying number allowing comparisons between ABC and ABP. Comparisons focused on HCF ranking rather than actual ABC or ABP values. The two ways of HCF ranking were compared using Spearman's rank correlation, which is a Pearson correlation coefficient calculated with the ranks of the values of each of the two variables, instead of their actual values.[15] No assumption was made about the distribution of the data. A correlation was considered as very strong (linear) if the correlation coefficient $\rho$ was $\geq 0.8$, strong if $0.6 \leq \rho < 0.8$, moderate if $0.4 \leq \rho < 0.6$ and weak if $\rho < 0.4$. To take into account HCF characteristics, the correlation was also analysed according to: HCF type, in reference to French administrative classification (including teaching and non-teaching hospitals); size; and the clinical activity of the wards (i.e. medicine, surgery, gynaecology, rehabilitation, long-term care, psychiatry).[16] Comparisons were also performed per selected antibiotic or antibiotic class. Stata software version 11.0 (StataCorp, College Station, TX, USA) was used for all analyses. A $P$ value of $<0.05$ was considered statistically significant.

## Results

### Selection and description of participating hospitals

For the year 2012, a total of 1411 HCFs participated in ATB-Raisin, whereas 1938 participated in the PPS. Among them, 1076 HCFs participated in both. This included 328 non-teaching public hospitals, 276 non-teaching private hospitals, 241 rehabilitation centres, 99 psychiatric hospitals, 68 local hospitals, 36 teaching hospitals, 11 cancer hospitals, 10 long-term care units and 7 military teaching hospitals (Table 1). Facilities were public (46.4%), private (35.7%) and private 'not for profit' (17.9%). There were as many hospitals including $\leq$100 beds (39.7%) as hospitals including 101–300 beds (40.3%), whereas hospitals including >300 beds constituted a minority (20.0%; Table 2).

### HCF ranking by global consumption and identification of outliers

ABC ranged from 2.33 to 1133.87 DDD/1000 PD [median 299.91, IQR (157.07–468.86)] whereas ABP ranged from 0% to 49.23% [median 13.94, IQR (7.00–20.75)] (Figure 1). HCF ranking according to either ABC or ABP was strongly correlated ($\rho = 0.79$, $P \leq 10^{-4}$), as shown in Figure 2. However, HCFs with the highest and lowest ABU differed according to either ABC or ABP. In addition, 39 HCFs had a zero ABP, including 14 psychiatric and 10 rehabilitation HCFs, while only 14 of them (35.9%) were among the 50 HCFs with the lowest ABC. Among the 50 HCFs with either the highest ABC or ABP, only 5 (10%) were common to the two methods. No HCF was identified as an inferior outlier, meaning that none of them was prescribing less than the rest of the group [i.e. ABC or $ABP < p25 - 1.5 \times (p75 - p25)$] with either method.

Among the nine HCFs considered outliers for ABP (0.84% of the total), eight of them (88.89%) were not outliers for ABC. On the

**Table 1.** Description of participating HCFs

| | Number (%) of participating HCFs | Number of beds, median (IQR) |
|---|---|---|
| Type | | |
| military teaching hospitals | 7 (0.7) | 229 (196–296) |
| teaching hospitals, public | 36 (3.3) | 825 (388–1386) |
| non-teaching hospitals, public | 328 (30.5) | 247 (134–450) |
| non-teaching hospitals, private | 276 (25.7) | 131 (85–201) |
| cancer hospitals | 11 (1.0) | 118 (79–167) |
| rehabilitation centres | 241 (22.4) | 85 (60–111) |
| local hospitals | 68 (6.3) | 52 (34–70) |
| long-term care hospitals | 10 (0.9) | 63 (30–80) |
| psychiatric hospitals | 99 (9.2) | 155 (79–322) |
| Status | | |
| public | 499 (46.4) | 226 (91–435) |
| private 'for profit' | 384 (35.7) | 98 (70–153) |
| private 'not for profit' | 193 (17.9) | 106 (75–180) |

**Table 2.** Spearman's correlation coefficient between HCF ranking according to ABU expressed as consumption in DDD/1000 PD or as prevalence, according to different facilities' characteristics

| | *n* (%) | ABC (DDD/1000 PD), median (p25–p75) | ABP (%), median (p25–p75) | ρ | *P* |
|---|---|---|---|---|---|
| Type | | | | | |
| non-teaching, public | 328 (30.5) | 419.3 (313.0–520.5) | 23.5 (17.8–30.0) | 0.72 | $<10^{-4}$ |
| non-teaching, private | 276 (25.7) | 436.1 (333.5–526.8) | 23.1 (16.3–31.5) | 0.36 | $<10^{-4}$ |
| rehabilitation | 241 (22.4) | 165.4 (112.2–214.7) | 9.1 (5.6–13.5) | 0.51 | $<10^{-4}$ |
| psychiatric | 99 (9.2) | 51.2 (35.8–68.6) | 2.4 (1.1–3.3) | 0.33 | $<10^{-4}$ |
| local | 68 (6.3) | 173.7 (139.6–228.8) | 10.0 (4.9–17.4) | 0.41 | $<10^{-4}$ |
| teaching, public | 36 (3.3) | 550.1 (384.5–680.7) | 32.3 (22.6–37.3) | 0.87 | $<10^{-4}$ |
| cancer centre | 11 (1.0) | 419.9 (358.1–521.4) | 32.9 (27.0–36.4) | 0.55 | $<10^{-4}$ |
| long-term care | 10 (0.9) | 83.1 (50.6–119.3) | 3.0 (0.0–9.4) | 0.74 | $<10^{-4}$ |
| military teaching | 7 (0.7) | 550.3 (531.4–693.4) | 35.5 (27.8–44.8) | 0.75 | $<10^{-4}$ |
| Size | | | | | |
| ≤100 beds | 427 (39.7) | 194.3 (119.7–314.6) | 11.1 (5.5–20.9) | 0.69 | $<10^{-4}$ |
| 101–300 beds | 434 (40.3) | 357.3 (189.4–492.0) | 19.1 (10.4–27.8) | 0.81 | $<10^{-4}$ |
| >300 beds | 215 (20.0) | 442.2 (321.4–536.3) | 25.2 (17.0–30.5) | 0.81 | $<10^{-4}$ |

other hand, five HCFs (0.46% of the total) were identified as outliers for ABC, while four of them (80.0%) were not detected as such for ABP. Both ABC and ABP methods defined only one HCF as an outlier in common (1 of 13; 7.69%).

### *HCF ranking according to type*

HCF ranking according to ABC or ABP correlated for all HCFs, regardless of their status: Spearman's correlation coefficient was equal to 0.83 for public, 0.79 for private 'not for profit' and 0.71 for private 'for profit' facilities. According to the HCF type, the correlation coefficient between ranking for each method went from low (psychiatric facilities, $\rho = 0.33$) to very high values (teaching public hospitals, $\rho = 0.87$; Table 2). Detailed data on type are available (Figure S1, available as Supplementary data at *JAC-AMR* online).

### *HCF ranking according to size and clinical activity*

Spearman's correlation coefficient was very strong for HCFs with >300 or with 101–300 beds ($\rho = 0.81$ for both), whereas it was strong for HCF with ≤100 beds ($\rho = 0.69$; Table 2). The correlation between ABC and ABP varied according to the proportion of acute care beds: strong for HCFs with a low or moderate proportion of acute care beds ($\rho = 0.69$ and 0.66, respectively), whereas moderate when this proportion was more than 66% ($\rho = 0.46$). Median ABU per ward was highest according to both ABP and ABC for ICU, medicine and surgery and lowest for psychiatry (also according to both methods; Table 3). However, the ranking differed for paediatric, gynaecology/obstetric, long-term care and rehabilitation wards. Spearman's correlation coefficient was globally moderate (rehabilitation and medicine units) or weak (ICU, surgery, paediatric, gynaecology/obstetric, psychiatric and long-term care units). The proportion of HCFs identified as outliers for ABC ranged from

0.61% (ICU) to 4.78% (long-term care) and for ABP from 0.0% (ICU) to 4.19% (rehabilitation centres). Most outliers defined by one method were not outliers for the other (between 8.9% and 100%). Hence, the proportion of HCFs identified as outliers by both ABC and ABP was null for ICU, surgery, paediatric and psychiatric wards and peaked at 11.11% for medicine wards (Table 3).

### *HCF ranking according to antibiotic or antibiotic class*

As shown in Table 4 and Table S1, the correlation between HCF ranking according to either ABC or ABP was very strong for β-lactams ($\rho = 0.81$) and strong for aminoglycosides, quinolones and fluoroquinolones ($\rho = 0.69$ for each). This correlation was weaker for glycopeptides ($\rho = 0.62$), carbapenems ($\rho = 0.57$) and the macrolides, lincosamides and streptogramins class ($\rho = 0.51$). Among β-lactams, the correlation was lower for amoxicillin ($\rho = 0.47$) than for other antibiotics: $\rho = 0.65$ for piperacillin/tazobactam; $\rho = 0.72$ for amoxicillin/clavulanic acid; and $\rho = 0.78$ for IV third-generation cephalosporins (IV 3GCs). An important proportion of HCFs were identified as outliers by one or both methods: with ABC, 12.7% and 10.5% of the HCFs for aztreonam and piperacillin/tazobactam, respectively; with ABP, 24.7% and 22.4% of the HCFs for carbapenems and pseudomonal 3GCs, respectively. The proportion of HCFs identified as outliers by both methods ranged from 0% (β-lactams) to 42.6% (piperacillin/tazobactam). This proportion was notably small for IV 3GCs, amoxicillin and fluoroquinolones (4.55%, 5.26% and 5.26%, respectively). Overall, for several antibiotics or antibiotic classes, ABP identified more outliers than ABC.

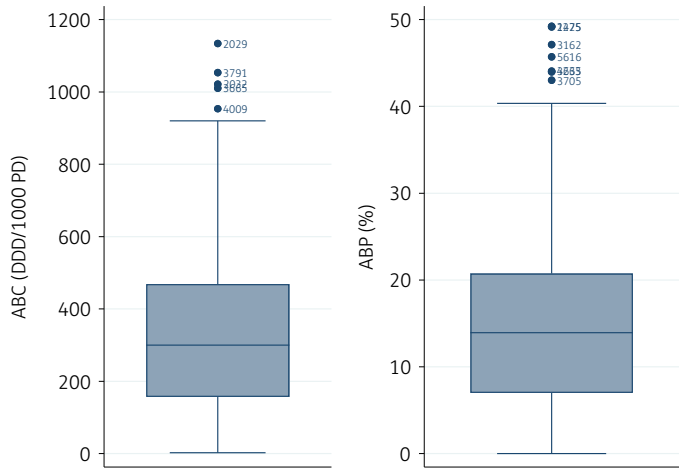


**Figure 1.** Distribution of antibiotic use in HCFs according to ABC (left panel) or ABP (right panel). Central lines, boxes and whiskers represent the median, IQR (Q3–Q1) and 1.5 times the IQR below the lower quartile or above the upper quartile, respectively. Outliers are defined in the Methods.

## Discussion

Our results showed a strong correlation of both ABU ranking methods. This correlation was strong for all HCFs and one could assume that ABC and ABP are interchangeable. However, several issues might challenge this statement.

First, when HCFs were stratified by HCF type or clinical ward, the correlation was less pronounced. Particularly, it was lower in HCFs with the highest proportion of acute care beds. This could be due to the variability of the inpatient profile on the day of the survey. It might also be due to seasonal differences in ABU. ABC data include yearly consumption while ABP data were collected at the end of spring. Besides, the ABP calculation method does not take into account multiple drugs on the day of the survey, while the ABC method includes all antibiotic consumption.

On the other hand, the ranking of HCFs according to ABC or to ABP in psychiatric and rehabilitation HCFs correlated poorly. Patients hospitalized in these HCFs infrequently need antibiotic treatment, which may explain the null ABP observed in some HCFs. Thus, variability in ABU in these settings may be due to few patients requiring antibiotics. Likewise, ward ranking by ABP correlated poorly since ABP is uncertain owing to the small ward size, leading to a wide ABP variability. However, both methods identified the same wards with the highest (ICU, medicine, surgery) and lowest (psychiatry) ABU, even if the ranking was different for the other wards.

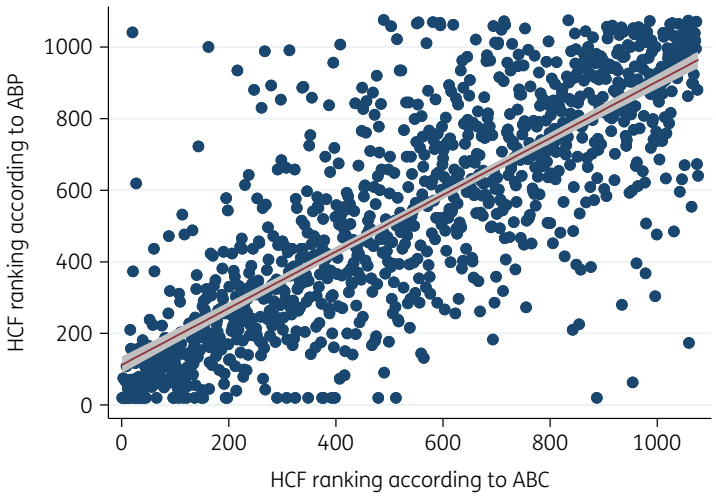


**Figure 2.** Spearman's rank coefficient correlation between ABC and ABP for total antibiotic use.

**Table 3.** Spearman's correlation coefficient between HCF ranking according to antibiotic global use expressed as consumption in DDD/1000 PD or as prevalence, distribution and proportion of outliers defined by both methods, according to clinical ward

| | | | | ABC (DDD/1000 PD) | | | ABP (%) | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Ward | *n* | ρ | *P* | Median (p25–p75) | Proportion of outliers, % (*n*) | Proportion of HCF that were ABC outliers but not ABP outliers (%) | Median (p25–p75) | Proportion of outliers, % (*n*) | Proportion of HCF that were ABP outliers but not ABC outliers (%) | Proportion of outliers according to both methods (%)[a] |
| Medicine | 440 | 0.49 | $<10^{-4}$ | 409 (342–526) | 0.9 (4) | 75 | 19.6 (10.3–28.0) | 1.4 (6) | 83 | 11.1 |
| ICU | 165 | 0.32 | $<10^{-4}$ | 1246(736–1538) | 0.6 (1) | 100 | 35.3 (27.3–57.9) | 0 (0) | — | 0 |
| Surgery | 337 | 0.39 | $<10^{-4}$ | 475 (353–560) | 1.2 (4) | 100 | 19.5 (13.4–28.1) | 1.5 (5) | 100 | 0 |
| Paediatric | 167 | 0.38 | $<10^{-4}$ | 169 (130–280) | 1.8 (3) | 100 | 2.1 (0.0–20.0) | 1.8 (3) | 100 | 0 |
| Gynaecology-obstetric | 254 | 0.25 | $<10^{-4}$ | 241 (211–308) | 3.5 (9) | 8.9 | 4.5 (0.0–11.1) | 3.9 (10) | 90 | 5.6 |
| Psychiatric | 193 | 0.25 | $<10^{-4}$ | 36 (22–51) | 1.6 (3) | 100 | 1.7 (0.0–2.6) | 1.6 (3) | 100 | 0 |
| Long-term care | 230 | 0.26 | $<10^{-4}$ | 72 (26–77) | 4.8 (11) | 91 | 2.5 (0.0–4.1) | 3.9 (9) | 89 | 5.3 |
| Rehabilitation | 597 | 0.50 | $<10^{-4}$ | 162 (108–211) | 2.5 (15) | 80 | 7.7 (4.7–11.1) | 4.2 (25) | 88 | 8.1 |

[a]Proportion of outliers according to both methods = (outliers in ABC and ABP)/(outliers in ABC and ABP + outliers in ABC + outliers in ABP).

Second, regarding specific antibiotics or antibiotic classes, ABC and ABP provided diverging results as well. Among the most commonly used antibiotics such as β-lactams or fluoroquinolones, there was generally a correlation between both methods. The correlation was weaker for antibiotics with low use such as pseudomonal 3GCs, carbapenems or aztreonam. However, even for amoxicillin, one of the top prescribed antibiotics, we did not observe a linear relationship between ranking per consumption and prevalence. One explanation could be that the amoxicillin DDD (i.e. 1 g in 2012, when data were recorded) did not accurately reflect the actual prescribed dose, which is at least 3 g for adult patients in French HCFs. The recent DDD modification to 1.5 g and 3 g for oral and injectable formulations, respectively, should minimize this discrepancy in the future, though 1.5 g still remains below the prescribed dose in most cases.[5]

For less commonly prescribed antibiotics (such as pseudomonal 3GCs, carbapenems or glycopeptides), more outliers were identified with ABP than with ABC. Again, the gap between the two methods could be explained by the selection of inpatients who may not necessitate these kinds of antibiotic on the given day the prevalence study was performed. Furthermore, there is a random effect, inherent to a 1 day prevalence survey, and this effect could be major for infrequently used drugs.

Third, the two methods did not identify the same highest prescribers. Besides, most of these HCFs were outliers only with one method. However, the proportion of clinical wards defined as outliers was below 5%, whatever the method used, and thus the impact of the disagreement between both methods was probably minimal. Seeing these results, we wonder if the criteria for defining outliers should not be changed by using a wider IQR (e.g. 10th to 90th percentiles) to select HCFs really differing from the group.

The interest in identifying potential inferior outliers for the global ABU is secondary compared with the superior outliers and the aim should not be to warn an HCF but to salute its antibiotic stewardship. The fact that none of the HCFs was defined in this way is consistent with the difficulty in significantly reducing the ABU compared with the vast majority of HCFs.

Since DDD does not reflect the recommended or prescribed dose for some of the most commonly prescribed drugs such as amoxicillin, many authors have tried to define a better indicator to estimate ABC.[17–24] DDDs were not developed to reflect prescribed doses or prescription quality but to compare consumption data. In addition, the information regarding the anatomical site or the severity of infection is not available. The use of PD as the denominator has also been questioned by several authors and, in some cases, other units seemed more relevant according to the type of structure, such as the number of admissions or the finished consultant episode.[25–27]

### *Implications for data surveillance*

DDD/1000 PD is currently the gold standard for ABU evaluation to allow benchmarking between different HCFs and countries.[28,29] ABC has the advantage of being easily collected and provides yearly data.

On the other hand, PPSs provide an overview of the current situation in HCFs and are dedicated to collecting patient and indication characteristics as well as information on antibiotic utilization (dosage, administration rhythm, duration of therapy) at the time of the survey. PPSs are feasible with limited resources.[7] Repeated surveys, be they local or European, allow estimation of a trend of overall ABU evolution and are sometimes the only source of information for countries that don't have a national surveillance network.[28,30] However, these surveys are only carried out in a given period, which limits the extrapolation for the entire year when patterns of infection are different due to seasonal variations. Furthermore, the HCFs participating in these surveys have different skills and the evaluation and grading might not be reproducible.

**Table 4.** Spearman's correlation coefficient between HCF ranking according to antibiotic global use expressed as consumption (ABC) or as prevalence (ABP) and proportion of outliers in ABC and in ABP, according to main antibiotic groups

| | | | ABC (DDD/1000 PD) | | ABP (%) | | |
|---|---|---|---|---|---|---|---|
| | ρ | *P* | Proportion of outliers, % (*n*) | Proportion of HCF that were ABC outliers but not ABP outliers (%) | Proportion of outliers, % (*n*) | Proportion of HCF that were ABP outliers but not ABC outliers (%) | Proportion of outliers according to both methods, % (*n*) |
| Total antibiotic consumption | 0.79 | $<10^{-4}$ | 0.5 (5) | 80 | 0.8 (9) | 88.9 | 7.7 (1) |
| Amoxicillin | 0.47 | $<10^{-4}$ | 2.9 (31) | 90.3 | 2.7 (29) | 89.7 | 5.3 (3) |
| Amoxicillin/clavulanic acid | 0.72 | $<10^{-4}$ | 0.9 (10) | 80 | 1.9 (20) | 90 | 7.1 (2) |
| Piperacillin/tazobactam | 0.65 | $<10^{-4}$ | 10.5 (113) | 21.2 | 17.2 (185) | 51.9 | 42.6 (89) |
| IV pseudomonal 3GCs[a] | 0.55 | $<10^{-4}$ | 8.0 (86) | 24.4 | 22.4 (241) | 73.0 | 24.8 (65) |
| IV non-pseudomonal 3GCs[b] | 0.78 | $<10^{-4}$ | 1.1 (12) | 91.7 | 1.1 (12) | 91.7 | 4.4 (1) |
| Carbapenems | 0.57 | $<10^{-4}$ | 7.9 (85) | 24.7 | 24.7 (266) | 75.9 | 22.3 (64) |
| Aztreonam | 0.24 | $<10^{-4}$ | 12.7 (137) | 92.7 | 1.1 (12) | 16.7 | 7.2 (10) |
| Tetracyclines | 0.35 | $<10^{-4}$ | 6.5 (70) | 57.1 | 15.8 (170) | 82.4 | 14.3 (30) |
| Sulphonamides | 0.50 | $<10^{-4}$ | 4.2 (45) | 57.8 | 6.6 (71) | 73.2 | 19.6 (19) |
| MLS | 0.51 | $<10^{-4}$ | 2.6 (28) | 67.9 | 3.4 (36) | 75 | 16.4 (9) |
| Aminoglycosides | 0.69 | $<10^{-4}$ | 3.6 (39) | 59.0 | 6.7 (72) | 77.8 | 16.8 (16) |
| Fluoroquinolones | 0.69 | $<10^{-4}$ | 1.8 (19) | 89.5 | 2.0 (21) | 90.5 | 5.3 (2) |
| Glycopeptides | 0.62 | $<10^{-4}$ | 6.0 (64) | 40.6 | 11.0 (118) | 67.8 | 26.4 (38) |
| Imidazole derivatives | 0.70 | $<10^{-4}$ | 2.7 (29) | 58.6 | 4.0 (43) | 72.1 | 20.0 (12) |
| Antibiotics for MRSA[c] | 0.64 | $<10^{-4}$ | 6.1 (66) | 39.4 | 9.4 (101) | 60.4 | 31.5 (40) |

MLS, macrolides, lincosamides and streptogramins.
[a]Cefepime, cefpirome, ceftazidime.
[b]Cefotaxime, ceftriaxone.
[c]Daptomycin, glycopeptides, linezolid.

At least two objectives of an ABU surveillance network can be defined.

- First, to provide ABU data at a regional, national or international level. These data are used by stakeholders, health authorities and HCFs to help them define and implement antibiotic policies.[11,31] In France, the regional centres for healthcare-associated infection prevention (CPias) play an important role in helping HCFs analyse their prescribing practices and implement stewardship measures. In this regard, ABC and ABP seem to provide equivalent results.
- Second, to identify and individually warn HCFs with ABU higher than other similar HCFs (so-called outliers). This warning is assumed to help them implement and target local antibiotic stewardship.[32–34] In this regard, ABC and ABP seem to provide divergent results by identifying different outliers.

This study is based on 2012 data, i.e. the latest data on ABP available in a large number of HCFs in France. To our knowledge, it is the first to compare the ABC and the ABP surveys, on a 1 year dataset from a national surveillance network and a PPS, in the same subset of more than 1000 HCFs. A large HCF participation in both surveys provided a strong database and ensured an appropriate representation of the French healthcare landscape in terms of status, geographic location, size and activities. Whether the same results would be observed in a different setting needs further investigations.

### *Conclusions*

In conclusion, these data show that ABC and ABP globally measured ABU in the same way, but diverged at the clinical ward or antibiotic level, as well as identifying different outliers. Our study was not designed to determine whether one was a better method than the other, but rather to compare them on the same set of data. Therefore, ABC and ABP could be used in a complementary way, keeping in mind these nuances when analysing antibiotic consumption data.

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None to declare.

## Supplementary data

Figure S1, Table S1 and Reviewer report 1 are available as Supplementary data at *JAC-AMR* Online.

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