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healthy all life long

HOW IS THE ANTIMICROBIAL SELECTION PRESSURE EVOLVING IN BELGIUM HEALTHCARE ?

One Health in Focus:

Advancing Solutions to Antimicrobial Resistance - AS2AMR

National surveillance of Inections in Healthcare Settings

– www.nsih.be -

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Boudewijn CATRY – May 2025

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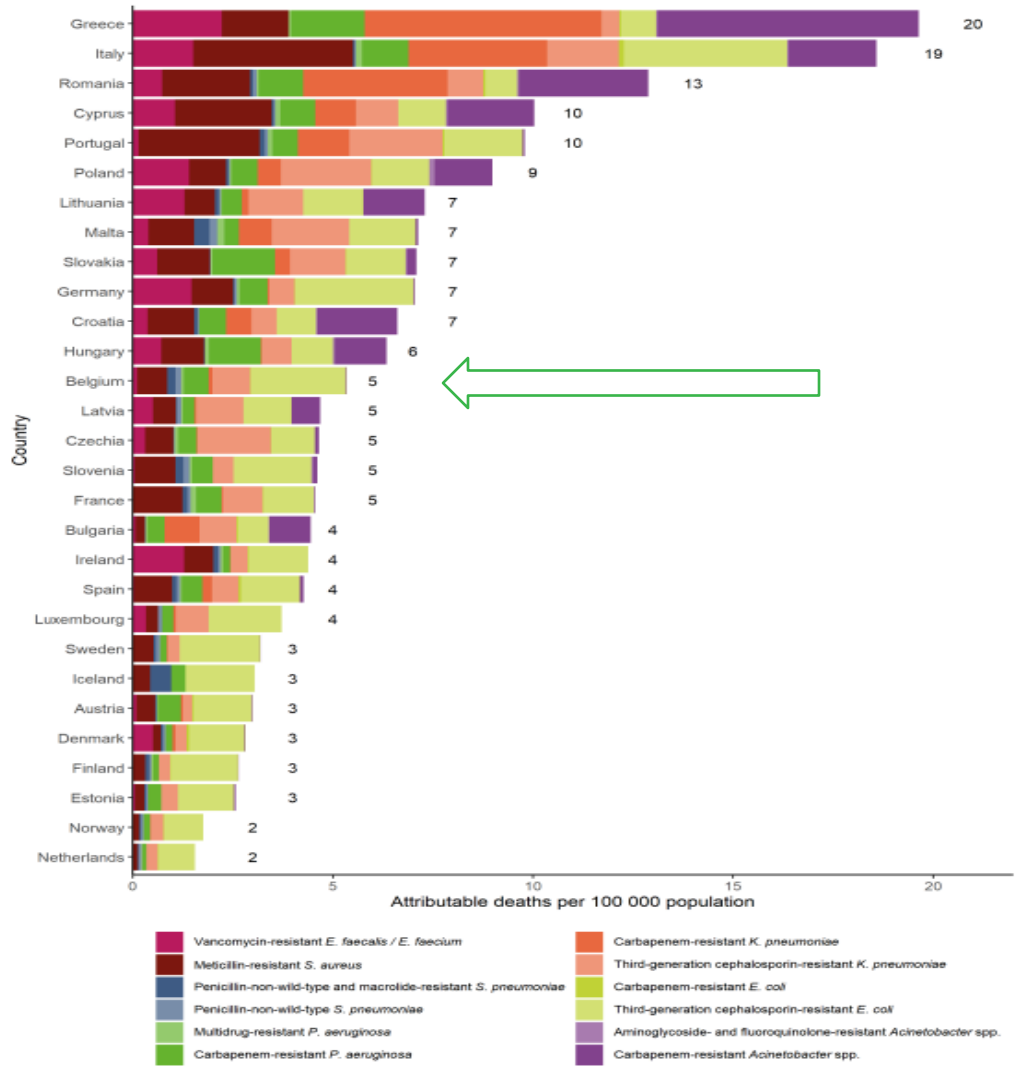
How is the EU progressing towards the 2030 antimicrobial resistance targets?

Reduce by 20% the total consumption of antibiotics in humans As defined daily doses (DDD) per 1 000 inhabitants per day	2019 Baseline	19.9	-
	2022	19.4	-2.5%
	2030 TARGET	15.9	-20%
At least 65% of the total consumption of antibiotics in humans belongs to the 'Access' group of antibiotics As defined in the AWaRe classification of the WHO *Population-weighted mean % consumption in 'Access' group. **Percentage point difference from 2019.	2019 Baseline	61.1%*	-
	2022	59.8%*	-1.3%**
	2030 TARGET	65%	+3.9%**
Reduce by 15% the total incidence of bloodstream infections with meticillin-resistant *Staphylococcus aureus* (MRSA) Number per 100 000 population	2019 Baseline	5.6	-
	2022	4.9	-12.2%
	2030 TARGET	4.8	-15%
Reduce by 10% the total incidence of bloodstream infections with third generation cephalosporin-resistant *Escherichia coli* Number per 100 000 population	2019 Baseline	10.4	-
	2022	8.7	-16.8%
	2030 TARGET	9.4	-10%
Reduce by 5% the total incidence of bloodstream infections with carbapenem-resistant *Klebsiella pneumoniae* Number per 100 000 population	2019 Baseline	2.2	-
	2022	3.3	+49.7%
	2030 TARGET	2.1	-5%

amr-brief-eaad-2023-update.pdf

Attributable deaths in Europe, due to AMR

Figure 5. Estimations of the burden of infections with antibiotic-resistant bacteria presented as attributable deaths per 100 000 population by country*, EU/EEA, 2020



*For Sweden, data reported to EARS-Net for 2016-2020 could not be checked for possible duplicate cases reported from the same patient.

https://www.ecdc.europa.eu/sites/default/files/documents/Health-burden-infections-antibiotic-resistant-bacteria.pdf

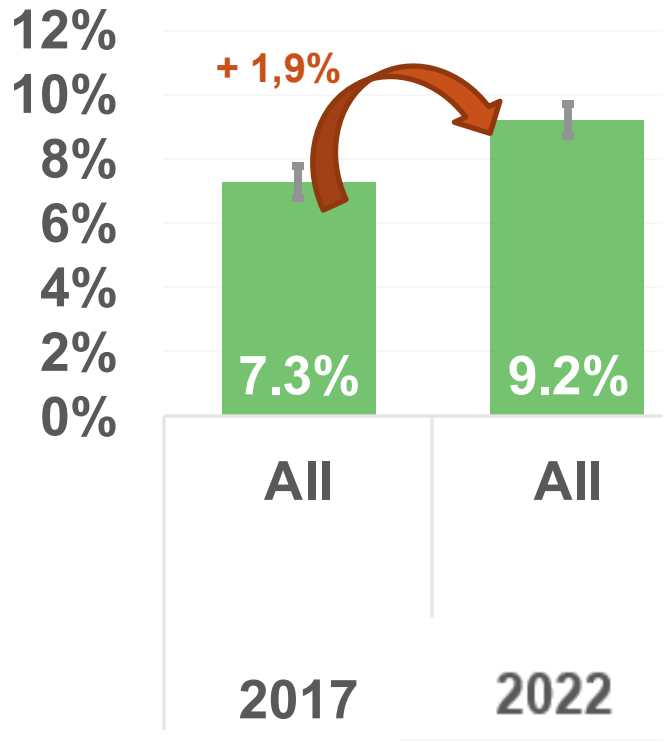
Attributable deaths AMR Belgium

Belgium: Estimated number of attributable deaths due to infections with antibiotic-resistant bacteria, EU/EEA, 2016-2020 (by decreasing number of attributable deaths in 2020)

	2016	2017	2018	2019	2020
Third-generation cephalosporin-resistant *E. coli*	316 (278 - 357)	351 (311 - 394)	323 (286 - 361)	347 (308 - 389)	274 (243 - 306)
Third-generation cephalosporin-resistant *K. pneumoniae*	110 (102 - 118)	114 (106 - 124)	146 (135 - 157)	123 (114 - 132)	109 (101 - 118)
Meticillin-resistant *S. aureus*	173 (156 - 192)	130 (117 - 144)	156 (141 - 172)	89 (80 - 98)	85 (77 - 94)
Carbapenem-resistant *P. aeruginosa*	53 (41 - 67)	56 (42 - 73)	49 (36 - 63)	81 (60 - 104)	72 (54 - 93)
Penicillin-non-wild-type and macrolide-resistant *S. pneumoniae*	1 (1 - 1)	0 (0 - 0)	0 (0 - 0)	31 (29 - 33)	25 (23 - 26)
Penicillin-non-wild-type *S. pneumoniae*	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	23 (21 - 24)	16 (15 - 18)
Vancomycin-resistant *E. faecalis / E. faecium*	6 (6 - 8)	35 (31 - 39)	14 (12 - 17)	10 (9 - 13)	13 (12 - 15)
Carbapenem-resistant *K. pneumoniae*	22 (18 - 25)	12 (9 - 15)	17 (14 - 20)	11 (8 - 14)	11 (8 - 14)
Multidrug-resistant *P. aeruginosa*	4 (2 - 7)	10 (7 - 14)	8 (4 - 14)	10 (7 - 14)	7 (5 - 10)
Carbapenem-resistant *Acinetobacter* spp.	2 (1 - 3)	9 (6 - 11)	5 (4 - 7)	0 (0 - 0)	2 (1 - 3)
Carbapenem-resistant *E. coli*	3 (2 - 4)	1 (1 - 2)	4 (3 - 5)	3 (2 - 4)	1 (1 - 2)
Aminoglycoside- and fluoroquinolone-resistant *Acinetobacter* spp.	0 (0 - 0)	1 (0 - 2)	2 (1 - 3)	0 (0 - 0)	1 (0 - 1)
Overall	690 (607 - 782)	719 (630 - 818)	724 (636 - 819)	728 (638 - 825)	616 (540 - 700)

https://www.ecdc.europa.eu/sites/default/files/documents/Annex_2_burden_estimates_country_sheets.pdf

Percentage of hospitalized patients with at least one healthcare-associated infection (HAI), ECDC-Point prevalence survey 2017 vs 2022



! 2022 includes
HAI associated to long term care facilities
Heathcare acquired (HA-)COVID-19

Top 10 most frequent isolated pathogens, ECDC-Point prevalence survey healthcare-associated infections (HAI), Belgium (49 hospitals)

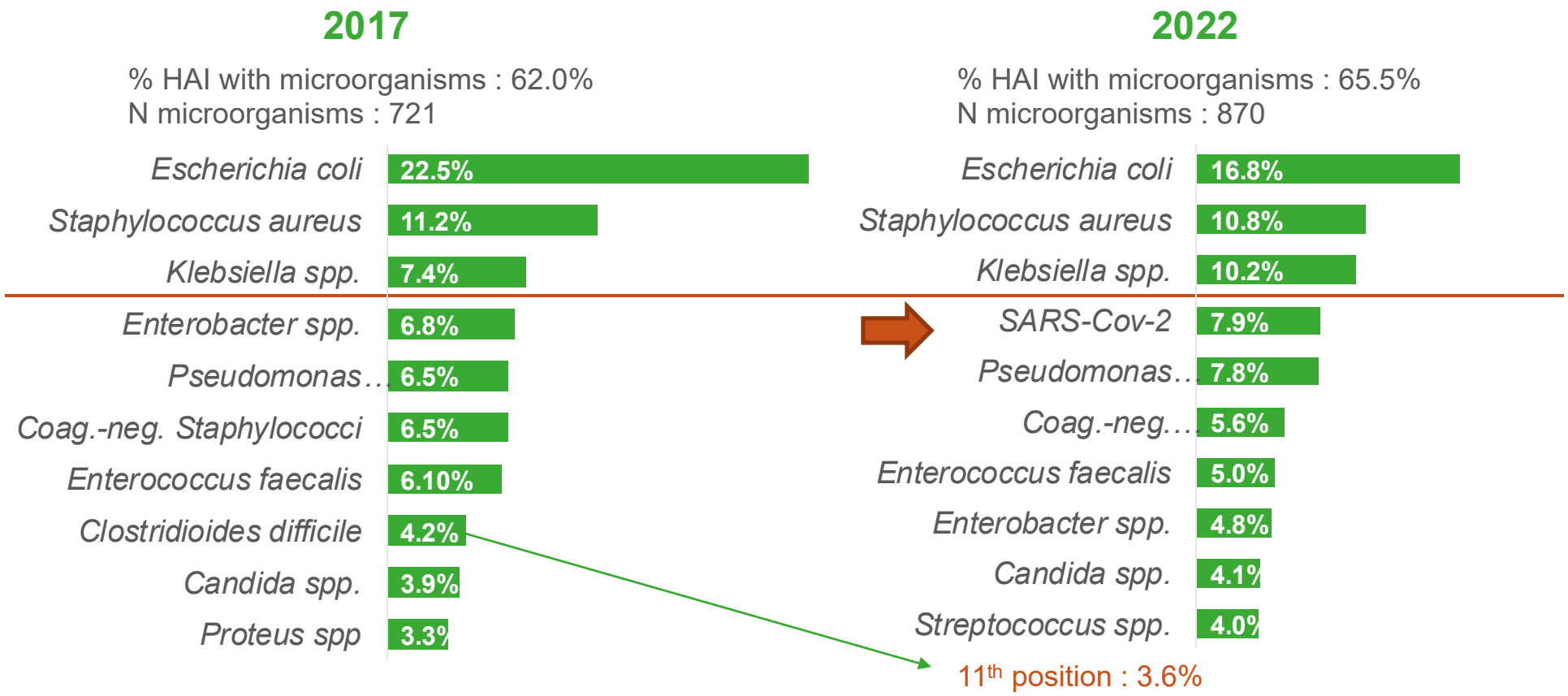


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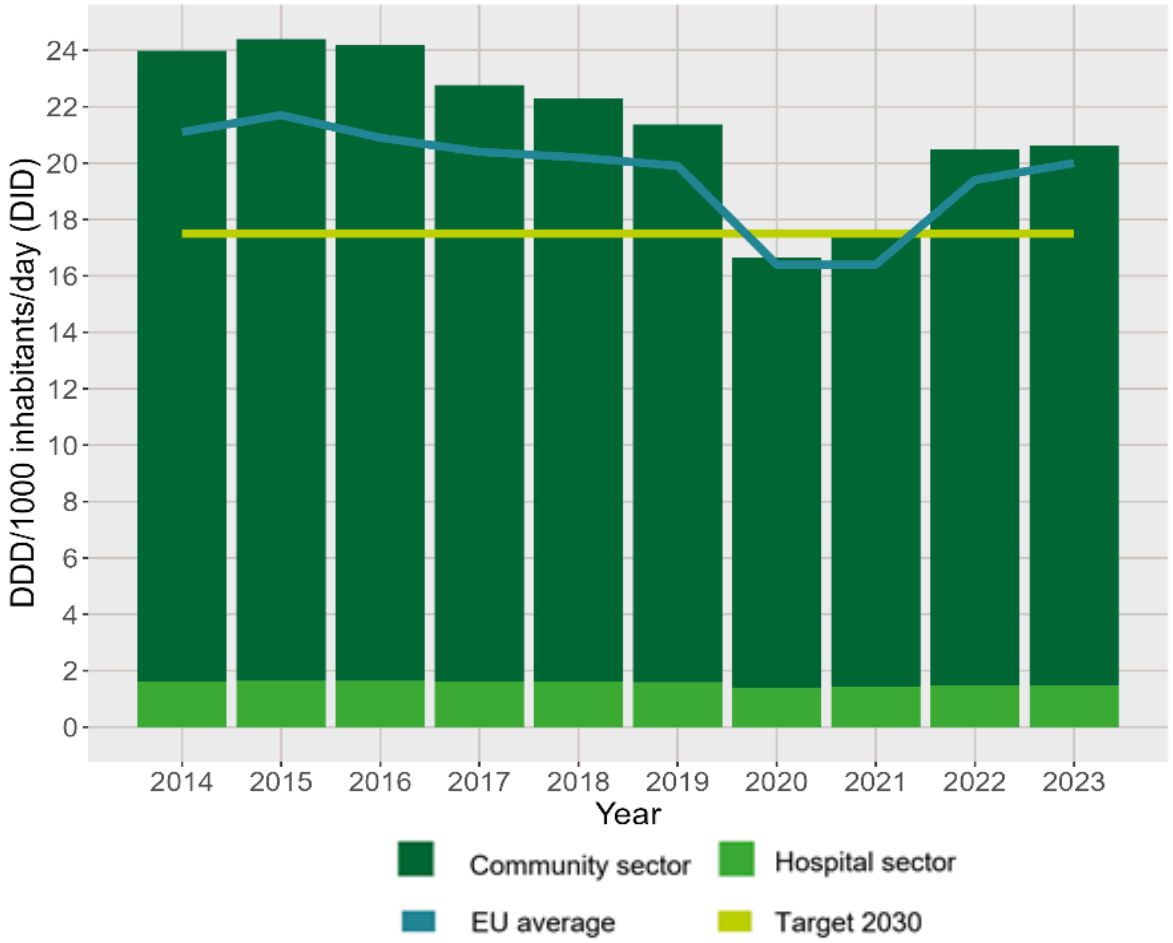
Figure 1.1 Evolution of total consumption in human medicine (community and hospital sectors combined) of systemic antibiotics (J01), 2014-2023 (ESAC-NET, 2023, Belgium)



Bonacini L, Catteau L et al., in preparation

Antimicrobial selection pressure

Interaction between host (age, disease type & incidence, comorbidities, diet, …)

Microorganism (nutrients, biofilms, transferable elements, size of population, …)

Antimicrobials:

- product (spectrum) & dose (concentration gradient): as targeted as possible
- formulation (route of administration) - least side effects
- treatment duration & treatment interval - as short as possible
  - Optimalisation = antimicrobial stewardship

Focus on healthcare: Community (ambulant/elderly/dentists) - Hospitals

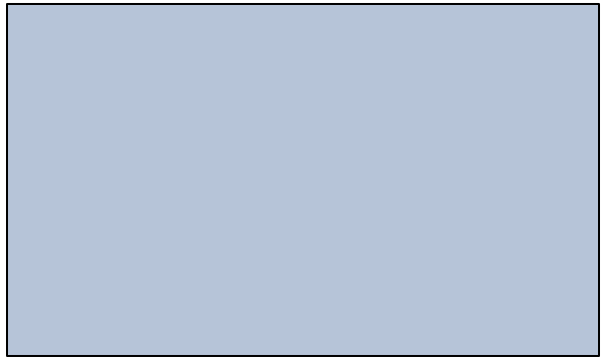
VOLATILE DEFINITIONS

“Little” international hurdles

Changing nomeclature

- *Clostridium difficile:*
- *Enterobacter aerogenes:*
- *Candida albicans:*
- *Candida glabrata:*
- *Mycoplasma genitalum:*

https://lpsn.dsmz.de/species/mycoplasma-ovis



Changing standard dose for antimicrobials

Defined daily dose

Changing interpretation criteria for antimicrobial resistance

° 2020 changes for meropenem – *Pseudomonas aeruginosa* (EUCAST)

influence on selection pressure? ⇨ project Sciensano: EUDIPA

IMPACT OF THE 2020 EUCAST « I » DEFINITION ON ANTIPSEUDOMONAL TREATMENT CHOICES IN BELGIAN HOSPITALS : A MULTICENTRIC STUDY

CATTEAU L.[1,2], BONACINI L.[1], EUDIPA Study Group, Belgian National Antibiogram Committee

1. Department of Epidemiology and public health, Sciensano, Brussels, Belgium • 2. Faculty of Medicine and Pharmacy, Université de Mons, Mons, Belgium

Introduction

- In 2020, **EUCAST redefined the "I" category** in antimicrobial susceptibility testing (AST) to **"Susceptible, at increased exposure"**, aiming to promote **narrow-spectrum antibiotic use.**
- By July 2022, **Belgian laboratories** adopted this change, classifying first-line **antipseudomonal antibiotics as "I"**, while **meropenem remained "S".**

Objectives

- **Assess the impact** of these changes **on antibiotic selection** for *Pseudomonas aeruginosa* infections in Belgian hospitals.
- **Identifying factors influencing meropenem prescriptions, as healthcare practitioners may now opt for broader-spectrum antibiotics in treatment.**

Methods

Design

- Multicentric retrospective observational study
- Belgian acute care hospitals patients - voluntary basis (informed consent)
- Risk factor analysis by logistic regression (Odd's ratio calculations)

Population

Hospitalized adults treated for wild-type *Pseudomonas aeruginosa* infections during a six-month period pre- or post-implementation of the new EUCAST definition

Patients were included in the study only if the isolate was identified as

Before 2020 update	After 2020 update
"S" : Susceptible	"S" : Susceptible, standard dose
"I" : Intermediate	"I" : Susceptible, increased exposure

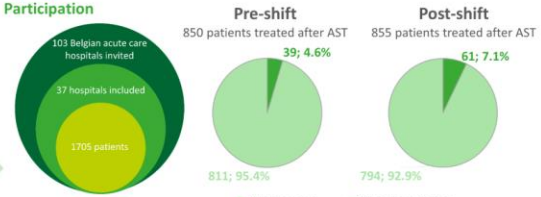
Data collection

November 2023 - June 2024 REDCap

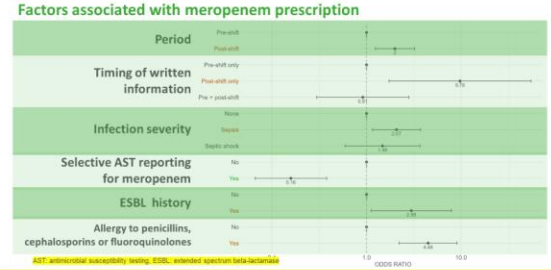
- Hospital data (characteristics, AST reporting strategies, information campaigns)
- Patient data (demographic, clinical, microbiological, and therapy details)

Results

Participation



Factors associated with meropenem prescription



Conclusion

- **The 2020 EUCAST criteria led to increased meropenem use for *P. aeruginosa* monobacterial infections in Belgium.**
- **Key factors influencing meropenem prescriptions:**
  - **EUCAST shift, delayed information campaigns, sepsis, ESBL history, and allergies to first-line antipseudomonal drugs are associated with increased meropenem use**
  - **Selective AST reporting may help reduce meropenem use**
- **Targeted antimicrobial stewardship programs can support appropriate antibiotic use.**

REFERENCES

- Munting, A., Damas, J., Viala, B., et al. (2022). Impact of selective reporting of antibiotic susceptibility testing results on meropenem prescriptions for the treatment of *Pseudomonas aeruginosa* infections after 2020 EUCAST criteria update: An observational study in a university hospital. Antimicrobial Resistance & Infection Control, 11, 165. https://doi.org/10.1186/s13756-022-01203-x
- Ourghanlian, C., Fihman, V., et al. (2022). Overly broad-spectrum antibiotic treatment of wild-type *Pseudomonas aeruginosa* infections in relation to the EUCAST new definition of susceptibility testing categories: A retrospective multicentre cohort study. JAC Antimicrobial Resistance. https://doi.org/10.1093/jacamr/dlac099
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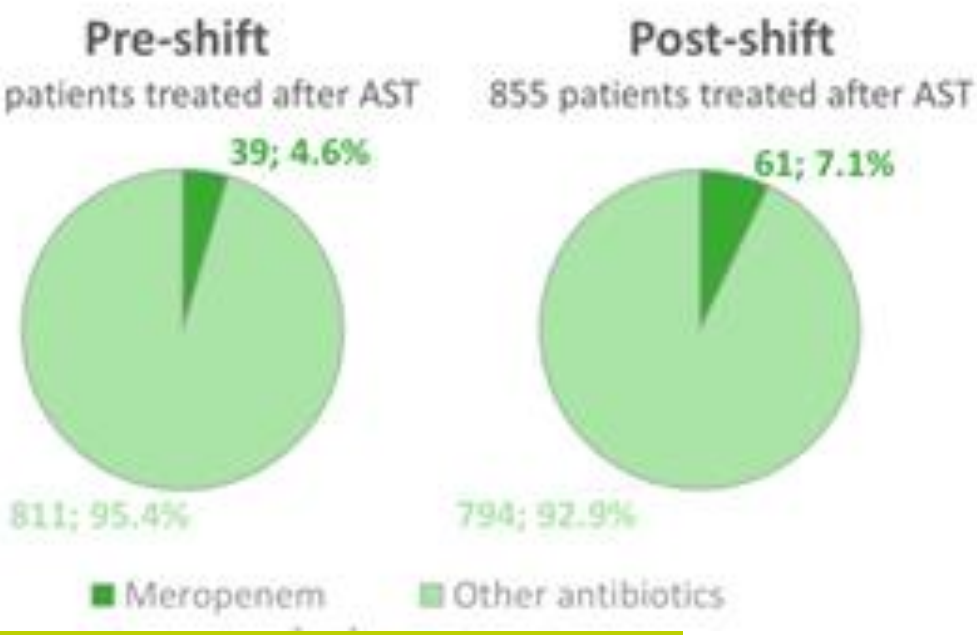

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Reduce by 20% the total consumption of antibiotics in humans As defined daily doses (DDD) per 1 000 inhabitants per day	2019 Baseline	19.9	-
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At least 65% of the total consumption of antibiotics in humans belongs to the 'Access' group of antibiotics As defined in the AWaRe classification of the WHO *Population-weighted mean % consumption in 'Access' group. **Percentage point difference from 2019.	2019 Baseline	61.1%*	-
	2022	59.8%*	-1.3%**
	2030 TARGET	65%	+3.9%**
Reduce by 15% the total incidence of bloodstream infections with meticillin-resistant *Staphylococcus aureus* (MRSA) Number per 100 000 population	2019 Baseline	5.6	-
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	2030 TARGET	4.8	-15%
Reduce by 10% the total incidence of bloodstream infections with third generation cephalosporin-resistant *Escherichia coli* Number per 100 000 population	2019 Baseline	10.4	-
	2022	8.7	-16.8%
	2030 TARGET	9.4	-10%
Reduce by 5% the total incidence of bloodstream infections with carbapenem-resistant *Klebsiella pneumoniae* Number per 100 000 population	2019 Baseline	2.2	-
	2022	3.3	+49.7%
	2030 TARGET	2.1	-5%

amr-brief-eaad-2023-update.pdf

Table 1. Estimated incidence of bloodstream infections with carbapenem resistance and trend 2019–2023, as well as the percentage change 2019–2023, EU/EEA, 2023 [1,2]

Country	Estimated incidence[a] of *K. pneumoniae* isolates from bloodstream infections with carbapenem resistance (n per 100 000 population)			
	2019	2023	Trend[b] 2019-2023	Change (%)[c] 2019-2023
Austria	0.20	0.29	-	+45.0
Belgium	0.27#	0.47#	↑	+74.1
Bulgaria	2.24#	7.75#	↑	+246.0
Croatia	1.2#	4.53	↑	+277.5
Cyprus	2.61	9.80	↑	+275.5
Czechia	0.09^	0.26^	↑	+188.9
Denmark	0.07	0.08	-	+14.3
Estonia	0.00^	0.44^	↑	NA
Finland	0.06	0.02	↓	-66.7
France	0.22	0.13 (2022)*	NA*	NA*
Germany	0.20#	0.25#	-	+25.0
Greece	13.05#	21.44	↑	+64.3
Hungary	0.09	0.76	↑	+744.4
Iceland	ND	0.00	NA	NA
Ireland	0.11	0.04	-	-63.6
Italy	8.43	9.29	-	+10.2
Latvia	0.00#	0.89#	↑	NA
Liechtenstein	ND	0.00#	NA	NA
Lithuania	0.54	0.73	-	+35.2
Luxembourg	0.16#	0.30	-	+87.5
Malta	2.13	0.97	-	-54.5
Netherlands	0.02	0.04	-	+100.0
Norway	0.04	0.08	-	+100.0
Poland	1.38#	3.69#	↑	+167.4
Portugal	2.93	4.19	↑	+43.0
Romania	7.12#	20.02#	↑	+181.2
Slovakia	0.52	1.33	-	+155.8
Slovenia	0.05	0.62	↑	+1 140
Spain	0.76#	0.96#	↑	+26.3
Sweden	0.03	0.12	↑	+300.0
EU[d]	**2.52**	**3.97**	↑	**+57.5**

https://www.ecdc.europa.eu/sites/default/files/documents/risk-assessment-carbapenem-resistant-enterobacterales-third-update-february-2025_0.pdf

Targets for Belgium

stream infections per 100,000 inhabitants) of some key resistant pathogens by the year 2030. These target reductions are set per country (Belgian targets in parentheses, black lines in figure below), in order to achieve an EU-wide 15% reduction in MRSA (Belgian target -6%), 10% reduction in 3rd generation cephalosporins-resistant *E. coli* (Belgian target -12%) and 5% reduction in carbapenem resistant *K. pneumoniae* (Belgian target -2%) blood stream infections, considering 2019 as the reference year. Here we calculated these metrics using the same methodology as used for European benchmarking - namely the number of cases of bloodstream infections reported in the EARS-BE surveillance was divided by the population size (Eurostat data) multiplied by an estimate of the population coverage of participating hospitals each year. As discussed in the ECDC report, this methodology has limitations, this methodology will therefore be validated at a national level against data from the mandatory blood stream infection surveillance during 2025. While for two of the three indicators Belgium already achieved the target in the years since 2020, we see an increase in incidence in all three indicators between 2022 and 2023, emphasizing the need for continued vigilance.

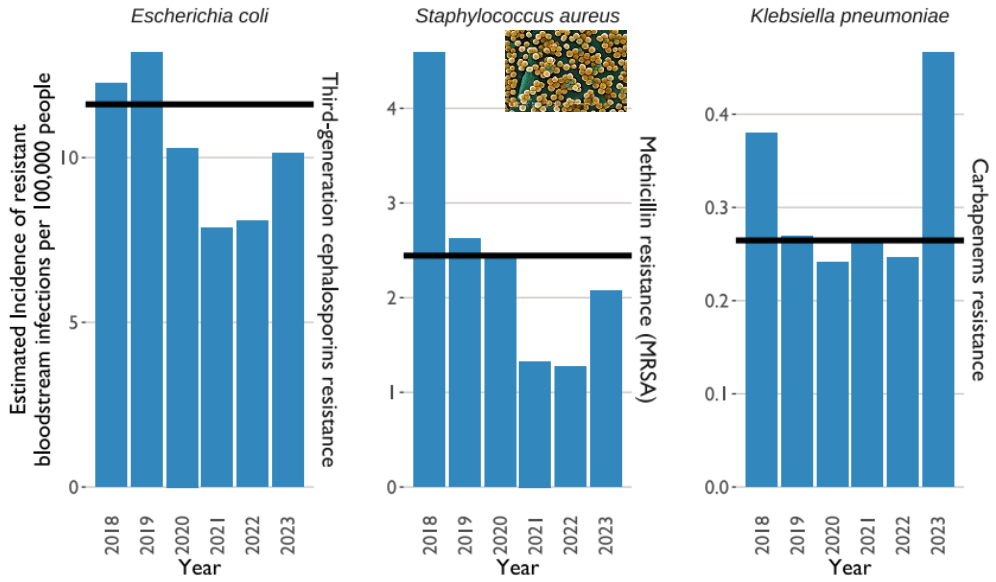

Figure G. Estimated incidence of resistant bloodstream infections per 100,000 inhabitants.

Volontary national surveillance EARS-net

(selection – clinical laboratories)

Vilain A, et al. 2025

Estimated total incidence of bloodstream infections with resistance phenotype (n per 100 000 population) and trend, 2019-2023, as well as the percentage change 2019-2023, by bacterial species and antimicrobial group/agent, Belgium

Bacterial species	Antimicrobial group/agent	Estimated incidence[a] of isolates from bloodstream infections with resistance phenotype (n per 100 000 population)						
		2019	2020	2021	2022	2023	Trend 2019-2023[b]	Change 2019-2023 (%)[c]
Escherichia coli	Aminopenicillin (amoxicillin/ampicillin) resistance	68.26#	54.60	48.72	48.70#	52.45#	↓	-23.2
	Third-generation cephalosporin (cefotaxime/ceftriaxone/ceftazidime) resistance	13.19#	10.29	7.84	8.07#	10.14#	-	-23.1
	Carbapenem (imipenem/meropenem) resistance	0.07#	0.02	0.04	0.06#	0.08#	-	14.3
	Fluoroquinolone (ciprofloxacin/levofloxacin/ofloxacin) resistance	25.11#	18.83	17.59	16.29#	18.33#	↓	-27.0
	Aminoglycoside (gentamicin/netilmicin/tobramycin) resistance[d]	9.10#	7.76	5.21	4.89^#	6.20^#	↓	-31.9
	Combined resistance to third-generation cephalosporins, fluoroquinolones, and aminoglycosides[d]	3.93#	2.99	1.43	1.56^#	2.17^#	↓	-44.8
	Third-generation cephalosporin (cefotaxime/ceftriaxone/ceftazidime) resistance	4.97#	4.34	3.52	3.30#	3.95#	↓	-20.5
	Carbapenem (imipenem/meropenem) resistance	0.27#	0.24	0.26	0.25#	0.47#	-	74.1
	Fluoroquinolone (ciprofloxacin/levofloxacin/ofloxacin) resistance	5.04#	5.01	3.54	3.66#	4.34#	-	-13.9
	Aminoglycoside (gentamicin/netilmicin/tobramycin) resistance[d]	2.89#	2.87	1.67	1.58^#	1.85^#	↓	-36.0
	Combined resistance to third-generation cephalosporins, fluoroquinolones, and aminoglycosides[d]	2.22#	2.27	1.37	1.25^#	1.46^#	↓	-34.2

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Volontary national surveillance EARS-net

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Vilain A, et al. 2025

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Bacterial species	Antimicrobial group/agent	Estimated incidence[a] of isolates from bloodstream infections with resistance phenotype (n per 100 000 population)						
		2019	2020	2021	2022	2023	Trend 2019-2023[b]	Change 2019-2023 (%)[c]
Pseudomonas aeruginosa	Piperacillin-tazobactam resistance	1.78#	1.35	0.97	1.06#	1.16#	↓	-34.8
	Ceftazidime resistance	1.18#	1.06	0.74	0.82#	0.83#	-	-29.7
	Carbapenem (imipenem/meropenem) resistance	1.58#	1.42	1.03	1.37#	1.09#	-	-31.0
	Fluoroquinolone (ciprofloxacin/levofloxacin) resistance	2.12#	1.78	1.35	1.37#	1.48#	↓	-30.2
	Aminoglycoside (gentamicin/netilmicin/tobramycin) resistance[e]	1.04#	0.46^	0.36^	0.27^#	0.30^#	NA	-71.2
	Combined resistance to ≥3 antimicrobial groups (among piperacillin-tazobactam, ceftazidime, carbapenems, fluoroquinolones and aminoglycosides)[e]	0.87#	0.55^	0.40^	0.45^#	0.34^#	NA	-60.9
Acinetobacter species	Carbapenem (imipenem/meropenem) resistance	0.00#	0.05	0.04	0.08#	0.16#	↑	NA
	Fluoroquinolone (ciprofloxacin/levofloxacin) resistance	0.27#	0.53^	0.36^	0.27#	0.34#	-	25.9
	Aminoglycoside (gentamicin/netilmicin/tobramycin) resistance[d]	0.10#	0.10	0.16	0.04^#	0.14^#	-	40.0
	Combined resistance to carbapenems, fluoroquinolones and aminoglycosides[d]	0.00^#	0.02^	0.04^	0.00^#	0.04^#	-	NA
Staphylococcus aureus	MRSA[f]	2.62#	2.43	1.33	1.27#	2.07#	-	-21.0
Streptococcus pneumoniae	Penicillin non-wild-type[g]	1.51	1.18	1.44	1.94#	2.11#	↑	39.7
	Macrolide (azithromycin/clarithromycin/erythromycin) resistance	2.44	1.56	1.32	2.00#	2.38#	-	-2.5
	Combined penicillin non-wild-type and resistance to macrolides[g]	0.88	0.72	0.79	1.11#	1.22#	↑	38.6
Enterococcus faecalis	High-level gentamicin resistance	2.05^#	0.94^	0.60^	0.45^#	0.67^#	↓	-67.3
Enterococcus faecium	Vancomycin resistance	0.07#	0.34	0.28	0.12#	0.34#	-	385.7

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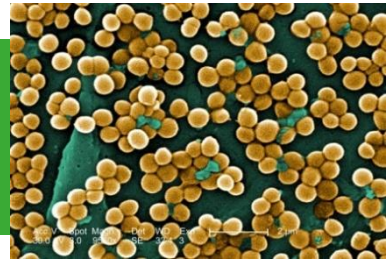
Mandatory surveillance antimicrobial resistance, Belgium hospitals

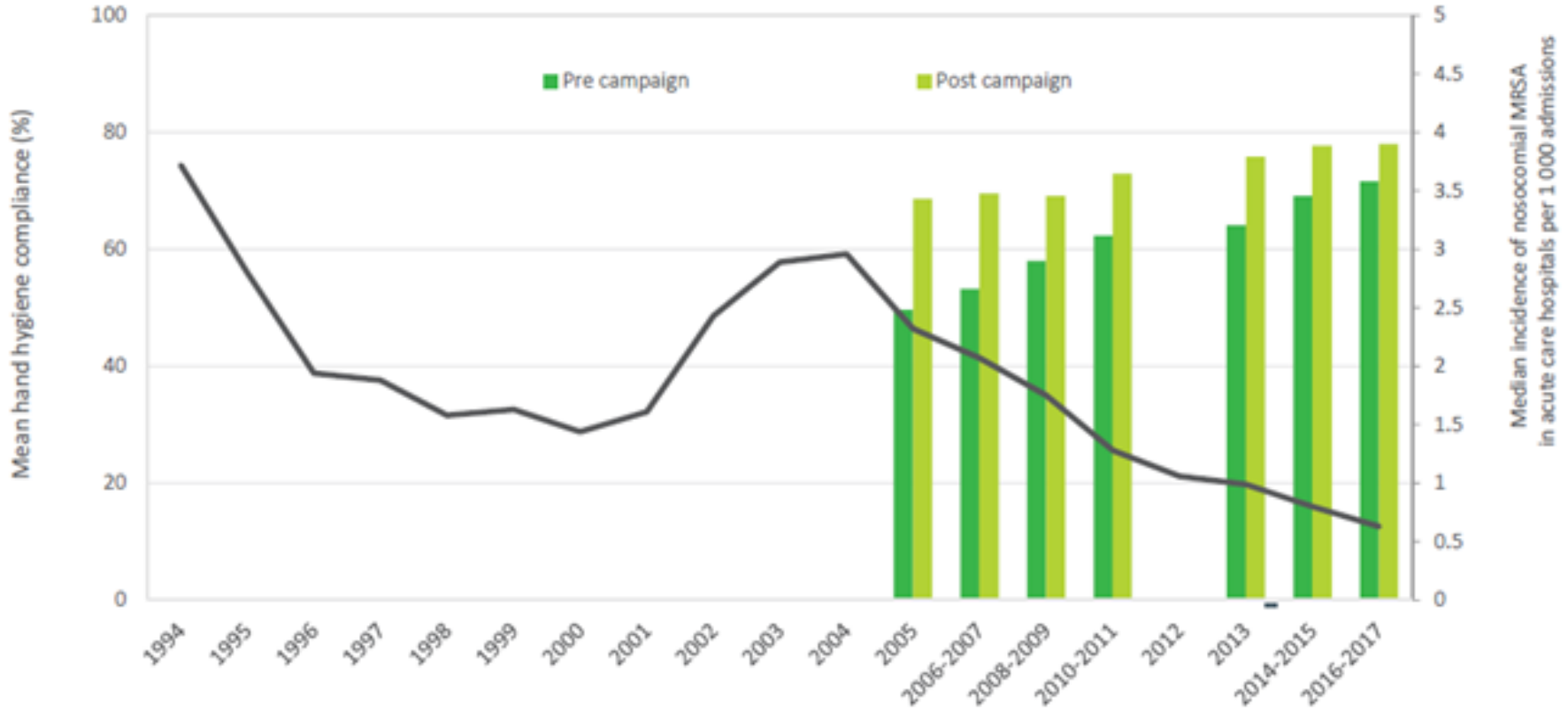
Table 1. Resistance proportion and incidence per 1 000 hospitalisations of the bacteria included in the surveillance of antimicrobial resistance (clinical samples only), Belgian acute care hospitals, 2023

		2023			
		Resistance proportion (%)		Incidence per 1 000 hospitalisations	
		Crude	Median	Crude	Median
Staphylococcus aureus	Methicillin R	8.8	8.4	1.36	1.20
Healthcare-associated *Staphylococcus aureus*	Methicillin R	24.1*	23.1*	0.33	0.23
Enterococcus faecium	Vancomycin R	1.89	0.00	0.091	0.000
Enterococcus faecalis	Vancomycin R	0.05	0.00	0.011	0.000
Escherichia coli	3GC-R	8.4	8.3	4.05	4.12
	Meropenem R	0.08	0.00	0.037	0.000
Klebsiella pneumoniae	3GC-R	17.6	16.8	2.00	1.80
	Meropenem R	1.07	0.35	0.121	0.044
Acinetobacter baumannii	Meropenem R	6.47	0.00	0.029	0.000
Pseudomonas aeruginosa	MDR	4.2	2.2	0.43	0.24

*Proportion healthcare-associated methicillin-resistant *Staphylococcus aureus* (MRSA) on total number of MRSA; R = resistant, 3GC = 3rd generation cephalosporins, MDR = resistance to at least three of the following antibiotic classes: fluoroquinolones (ciprofloxacin or levofloxacin), aminoglycosides (tobramycin or amikacin), carbapenems (meropenem or imipenem), 3rd and/or 4th generation cephalosporins (ceftazidime or cefepime)

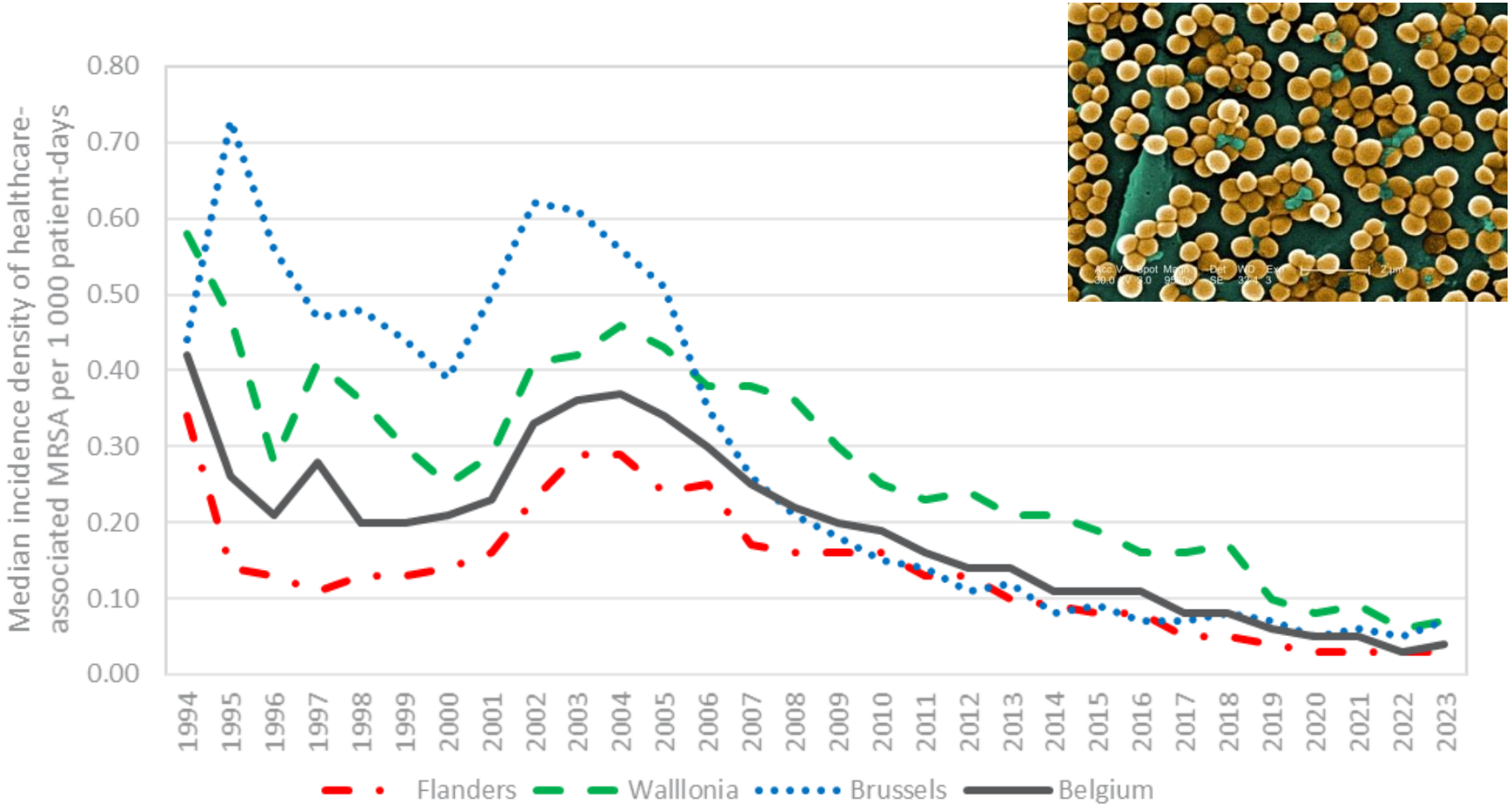
Mandatory surveillance methicillin resistant *S. aureus*
MRSA "vs" Hand hygiene campaigns





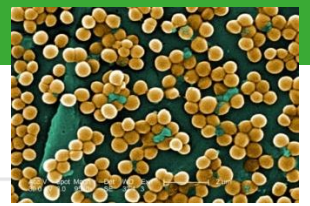
Latour et al., 2025

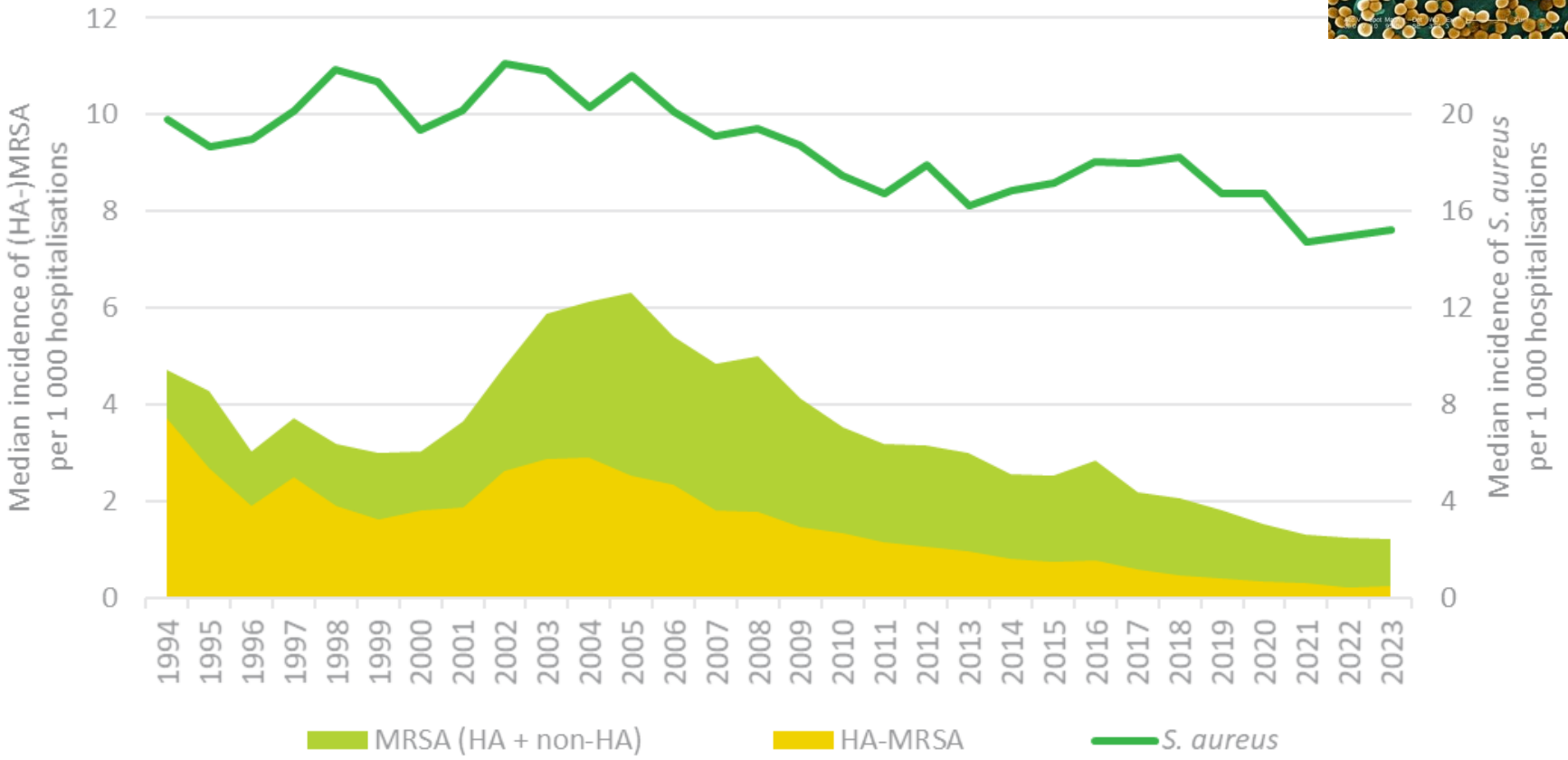
Figure 7. Evolution of the median incidence density of healthcare-associated methicillin-resistant Staphylococcus aureus (MRSA) per 1 000 patient-days by region (clinical samples only), Belgian acute care hospitals, 1994-2023



Latour et al., 2025

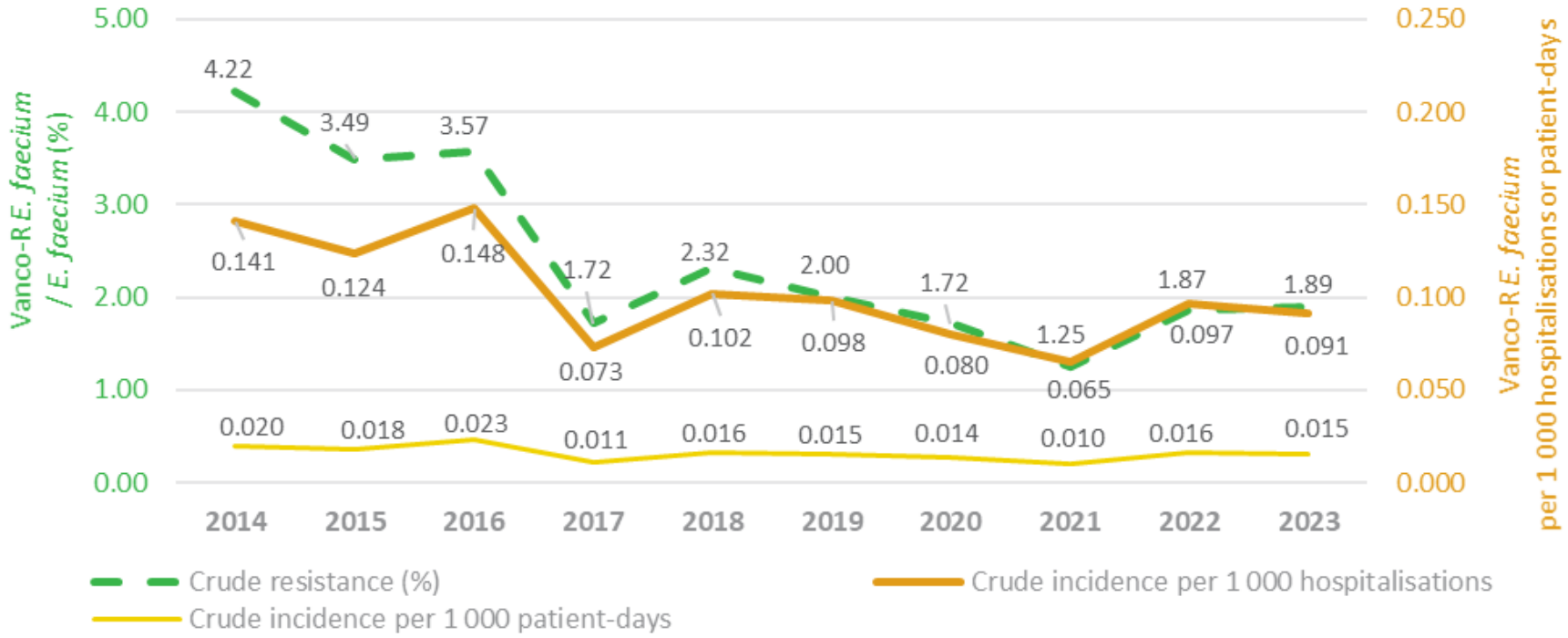
Figure 8. Evolution of the median incidence of *Staphylococcus (S.) aureus*, methicillin-resistant *S. aureus* (MRSA) and healthcare-associated (HA-)MRSA per 1 000 hospitalisations (clinical samples only), Belgian acute care hospitals, 1994-2023





Latour et al., 2025

Figure 14. Evolution of the crude resistance proportion, cumulative incidence (per 1 000 hospitalisations) and incidence density (per 1 000 patient-days) of vancomycin resistance in Enterococcus faecium (clinical samples only), Belgian acute care hospitals, 2014-2023



Note: Prior to 2016, vancomycin resistance was separated under vancomycin resistance (defined as vanco-R and susceptible to teicoplanin or susceptibility unknown) and glycopeptide resistance (defined as vanco-R and teicoplanin resistant). Since 2017, vancomycin resistance is questioned independently from the susceptibility to teicoplanin.

Vancomycin resistant enterococci: VRE

Table 10. Evolution of the number of outbreaks with vancomycin or linezolid resistant enterococci reported in the national surveillance in Belgian acute care hospitals, 2014-2023

	2014	2015	2016	2017	2018	2019	2020	2021	2022
Hospitals reporting an outbreak (%)	3/40 (7.5)	7/75 (9.3)	7/95 (7.4)	13/98 (13.3)	13/96 (13.5)	16/91 (17.6)	7/88 (8.0)	4/97 (4.1)	11/97 (11.3)
Hospitals with no answer	0	0	1	4	13	10	14	9	10
N of clusters (min-max)	3 (1-1)	11 (1-4)	12 (1-3)	21 (1-6)	28 (1-13)	19 (1-3)*	7 (1-2)*	3 (1-2)*	14 (1-3)*
Patients involved	68	140	247	166	164	268	27	10	244
% patients colonised	*79.4*	*87.7*	*88.8*	*89.8*	*88.4*	*94.4*	*77.8*	*90.0*	*87.3*
% patients infected	*20.6*	*12.3*	*11.2*	*10.2*	*11.6*	*5.6*	*22.2*	*10.0*	*12.7*

*data missing for two (2020, 2021, 2022, 2023) or three (2019) hospitals

Volontary national surveillance EARS-net

(selection – clinical laboratories)

Vilain A, et al. 2025

Estimated total incidence of bloodstream infections with resistance phenotype (n per 100 000 population) and trend, 2019-2023, as well as the percentage change 2019-2023, by bacterial species and antimicrobial group/agent, Belgium

Bacterial species	Antimicrobial group/agent	Estimated incidence[a] of isolates from bloodstream infections with resistance phenotype (n per 100 000 population)						
		2019	2020	2021	2022	2023	Trend 2019-2023[b]	Change 2019-2023 (%)[c]
Pseudomonas aeruginosa	Piperacillin-tazobactam resistance	1.78#	1.35	0.97	1.06#	1.16#	↓	-34.8
	Ceftazidime resistance	1.18#	1.06	0.74	0.82#	0.83#	-	-29.7
	Carbapenem (imipenem/meropenem) resistance	1.58#	1.42	1.03	1.37#	1.09#	-	-31.0
	Fluoroquinolone (ciprofloxacin/levofloxacin) resistance	2.12#	1.78	1.35	1.37#	1.48#	↓	-30.2
	Aminoglycoside (gentamicin/netilmicin/tobramycin) resistance[e]	1.04#	0.46^	0.36^	0.27^#	0.30^#	NA	-71.2
	Combined resistance to ≥3 antimicrobial groups (among piperacillin-tazobactam, ceftazidime, carbapenems, fluoroquinolones and aminoglycosides)[e]	0.87#	0.55^	0.40^	0.45^#	0.34^#	NA	-60.9
Acinetobacter species	Carbapenem (imipenem/meropenem) resistance	0.00#	0.05	0.04	0.08#	0.16#	↑	NA
	Fluoroquinolone (ciprofloxacin/levofloxacin) resistance	0.27#	0.53^	0.36^	0.27#	0.34#	-	25.9
	Aminoglycoside (gentamicin/netilmicin/tobramycin) resistance[d]	0.10#	0.10	0.16	0.04^#	0.14^#	-	40.0
	Combined resistance to carbapenems, fluoroquinolones and aminoglycosides[d]	0.00^#	0.02^	0.04^	0.00^#	0.04^#	-	NA
Staphylococcus aureus	MRSA[f]	2.62#	2.43	1.33	1.27#	2.07#	-	-21.0
Streptococcus pneumoniae	Penicillin non-wild-type[g]	1.51	1.18	1.44	1.94#	2.11#	↑	39.7
	Macrolide (azithromycin/clarithromycin/erythromycin) resistance	2.44	1.56	1.32	2.00#	2.38#	-	-2.5
	Combined penicillin non-wild-type and resistance to macrolides[g]	0.88	0.72	0.79	1.11#	1.22#	↑	38.6
Enterococcus faecalis	High-level gentamicin resistance	2.05^#	0.94^	0.60^	0.45^#	0.67^#	↓	-67.3
Enterococcus faecium	Vancomycin resistance	0.07#	0.34	0.28	0.12#	0.34#	-	385.7

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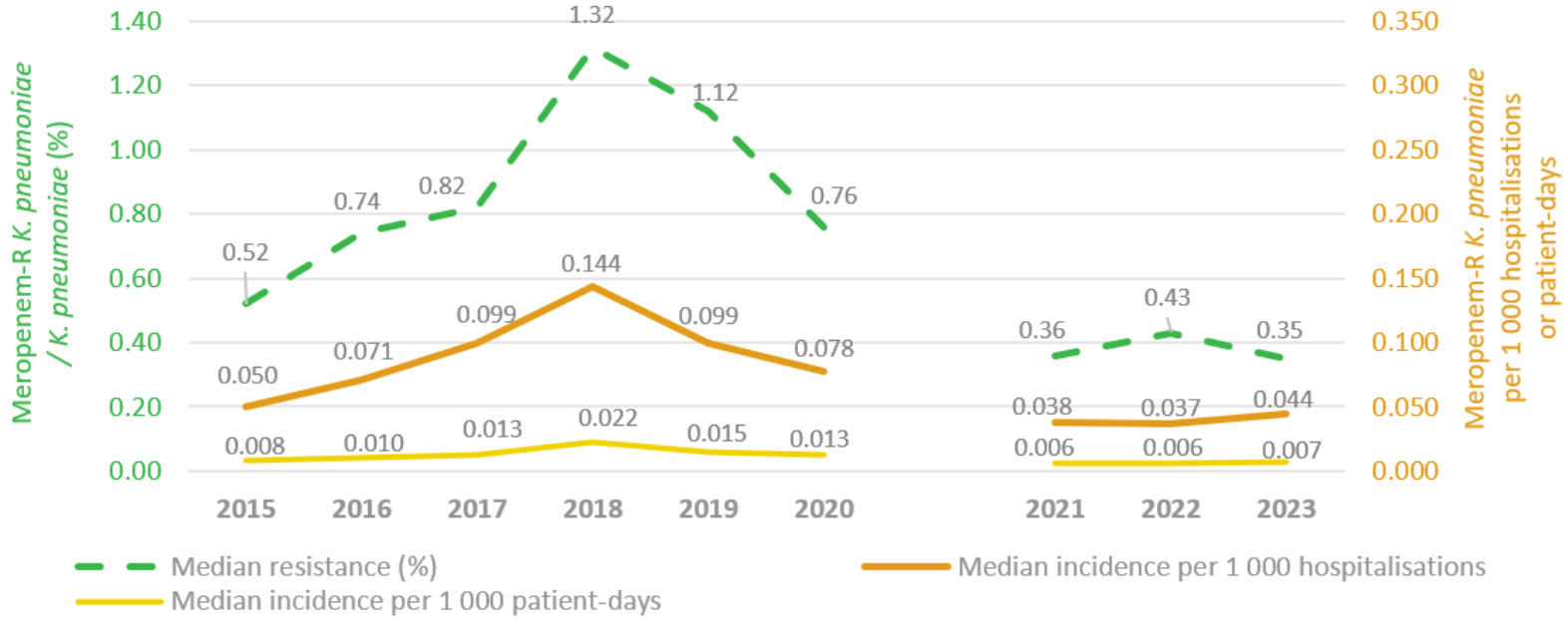
Mandatory national surveillance multi-drug resistant organisms (exhaustive – all acute care hospitals)

Figure 17. Evolution of the median resistance proportion, incidence (per 1 000 hospitalisations) and incidence density (per 1 000 patient-days) of *Klebsiella pneumoniae* resistant to meropenem (clinical samples only), Belgian acute care hospitals, 2014-2023



Note: prior to 2021 I/R (resistant, incl. also susceptible, increased exposure (intermediate result)) is displayed.

Latour K, et al. 2025

“New” oral carbapenems – Hazard(?)

- Clinical trials ongoing in Eastern European countries
  - No data on consumption in monitoring (ESAC-net)
- Publications arising to promote oral formulations:

Sewunet T, Razavi M, Rosenborg S, Camporeale A, Nowak M, Melnick D, Gasink LB, Eckburg PB, Critchley IA, Nord CE, Giske CG. Effect of tebipenem pivoxil hydrobromide on the normal gut microbiota of a healthy adult population in Sweden: a randomised controlled trial. Lancet Microbe. 2024 Apr;5(4):e355-e365. doi: 10.1016/S2666-5247(23)00360-9.

- Could lead to more selection in the digestive tract as seen with
  - beta-lactams & tetracyclines for commensals

Zhang L, Huang Y, Zhou Y, Buckley T, Wang HH. Antibiotic administration routes significantly influence the levels of antibiotic resistance in gut microbiota. Antimicrob Agents Chemother. 2013 Aug;57(8):3659-66. doi: 10.1128/AAC.00670-13.

  - other agents for uropathogens

Catry B, Latour K, Bruyndonckx R, Diba C, Geerdens C, Coenen S. Characteristics of the antibiotic regimen that affect antimicrobial resistance in urinary pathogens. Antimicrob Resist Infect Control. 2018 Jun 18;7:76. doi: 10.1186/s13756-018-0368-3. PMID: 29946451; PMCID: PMC6006702.

Carbapenem	Year of Introduction	Indications	Formulation (Prodrug if applicable)	Reference
Imipenem/Cilastatin	1985	Severe infections (skin, soft tissue, joint, respiratory, intra-abdominal, urinary tract, endocarditis, sepsis)	IV, IM	Link
Meropenem	1996	Complicated skin, soft tissue, intra-abdominal infections, bacterial meningitis	IV	Link
Ertapenem	2001 (US), 2002 (EU)	Intra-abdominal infections, pneumonia, pelvic infections, diabetic foot infections, surgical infection prevention	IV, IM	Link
Doripenem	2007	Complicated intra-abdominal and urinary tract infections (pyelonephritis)	IV	Link
Panipenem/Betamipron	1993 (Japan)	Various bacterial infections (betamipron reduces nephrotoxicity)	IV	Link
Biapenem	2001 (Japan)	Broad-spectrum bacterial infections	IV	Link
Tebipenem	2015 (Japan)	Pediatric infections (otitis media, pneumonia)	PO (Prodrug: Tebipenem pivoxil)	Link
Imipenem/Cilastatin/Relebactam	2019 (US)	Complicated urinary tract and intra-abdominal infections, hospital-acquired pneumonia	IV	Link
Faropenem	Approved in some countries	Respiratory and urinary tract infections	PO (No prodrug)	Link

https://en.wikipedia.org/wiki/Carbapenem

Unit of measurement

Sales in volume - Mg/kg – mg/kg biomass (One health comparisons)

Defined daily dose (WHO – international standards)

Treatment incidence:

Number of Defined Daily Dose per Inhabitant per Day

per Patient

per Beneficiary

per Resident

per Caregiver…..

BELGIAN HOSPITAL SECTOR

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The denominator in hospitals

Table 1: Trends in population and hospital activity metrics (admissions, patient-days[a] and length of stay[b] Belgium,2017-2022.

Denominator	2017	2018	2019	2020	2021	2022	Trend	P
Inhabitants (x 10^5)	114	114	115	115	116	116	++	<0.(
Admissions (x 10^5)	17.5	17.6	17.7	14.8	15.9	17.6		.
Patient-days (x 10^5)	118	118	117	100	103	107		.
Length of stay (days)	6.58	6.53	6.43	6.54	6.17	5.83	-	0.03

[a]excluding psychiatric and one-day hospitalization wards, [b]median of yearly length of stay calculated by dividing the number of patient-days by the number of admissions, aggregated at hospital level

Bonacini et al., in preparation

Selection pressure according to different metrics, Belgian hospitals 2017-2022

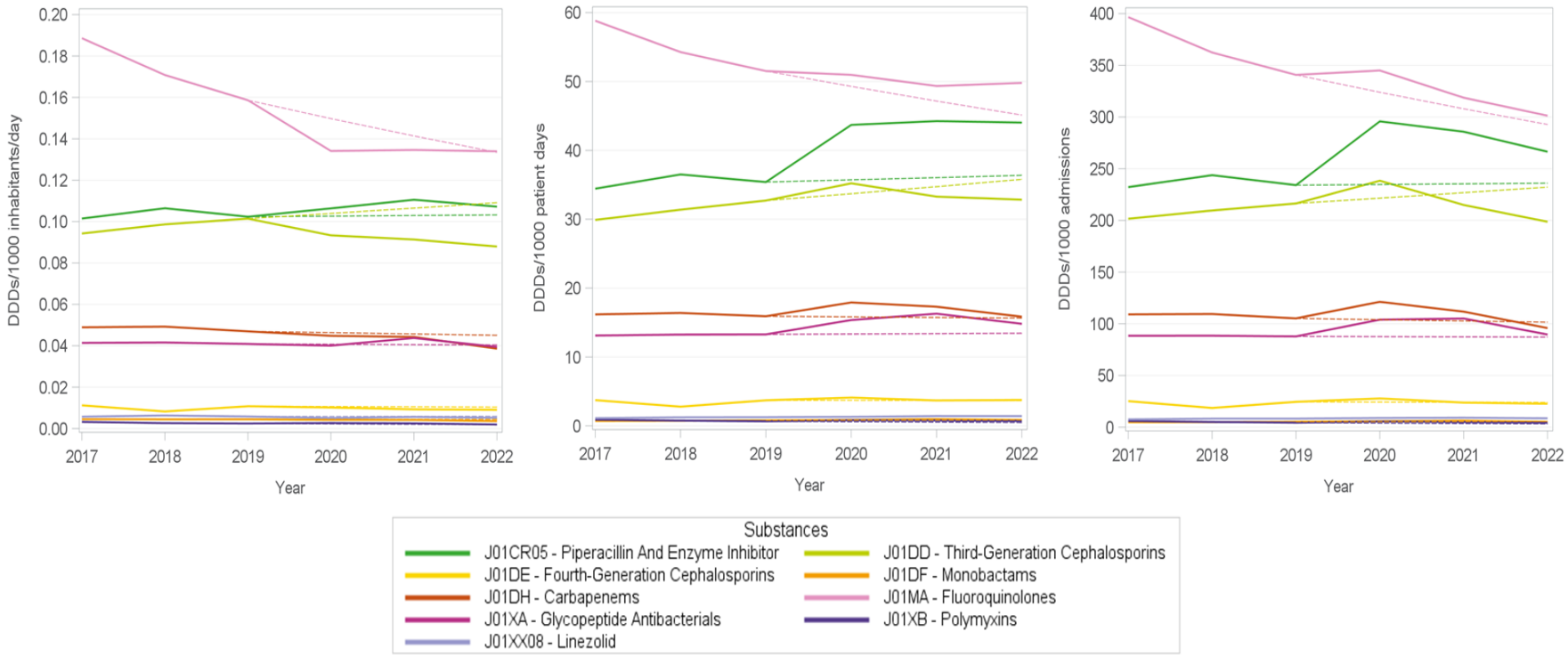

Figure 3: Actual and forecasted hospital consumption trends (2017-2022) of broad-spectrum antibacterials subclasses (ATC-4 or ATC-5 level) expressed in DDD/1000 inhabitants (A), DDD/1000 patient-days (B), and DDD/1000 admissions (C), Belgium.

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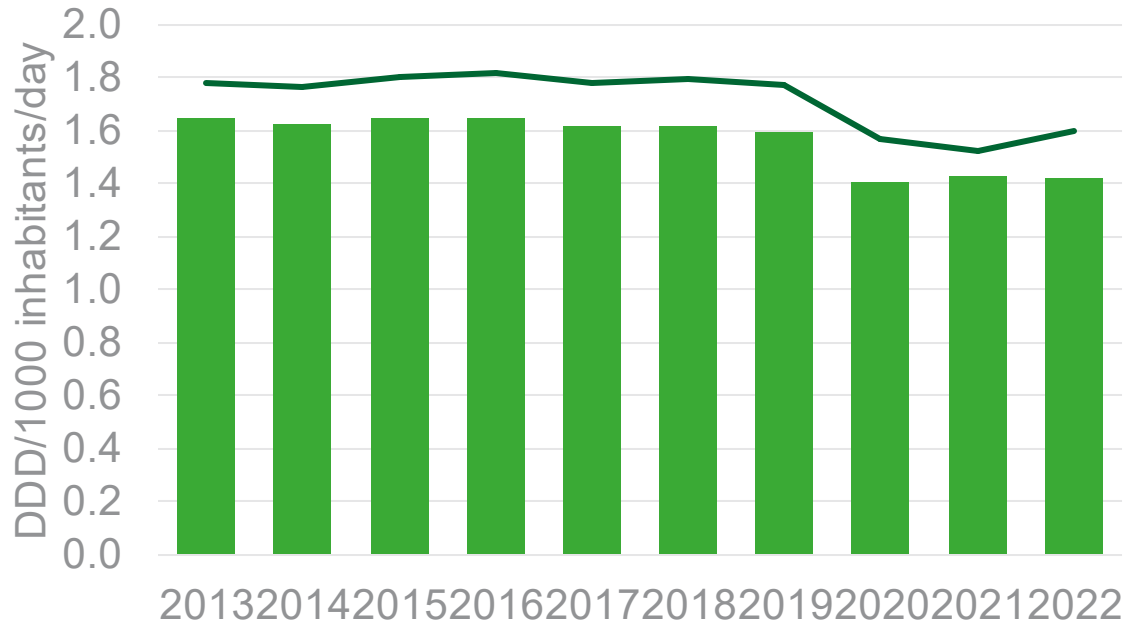
Bonacini et al., in preparation

ESAC-Net – DID = unrealistic optimistic



- Significant **decrease** (**13,6%**) between 2013 and 2022.
- Sharp decline of 11.9% between 2019/2020 stabilizing afterwards.

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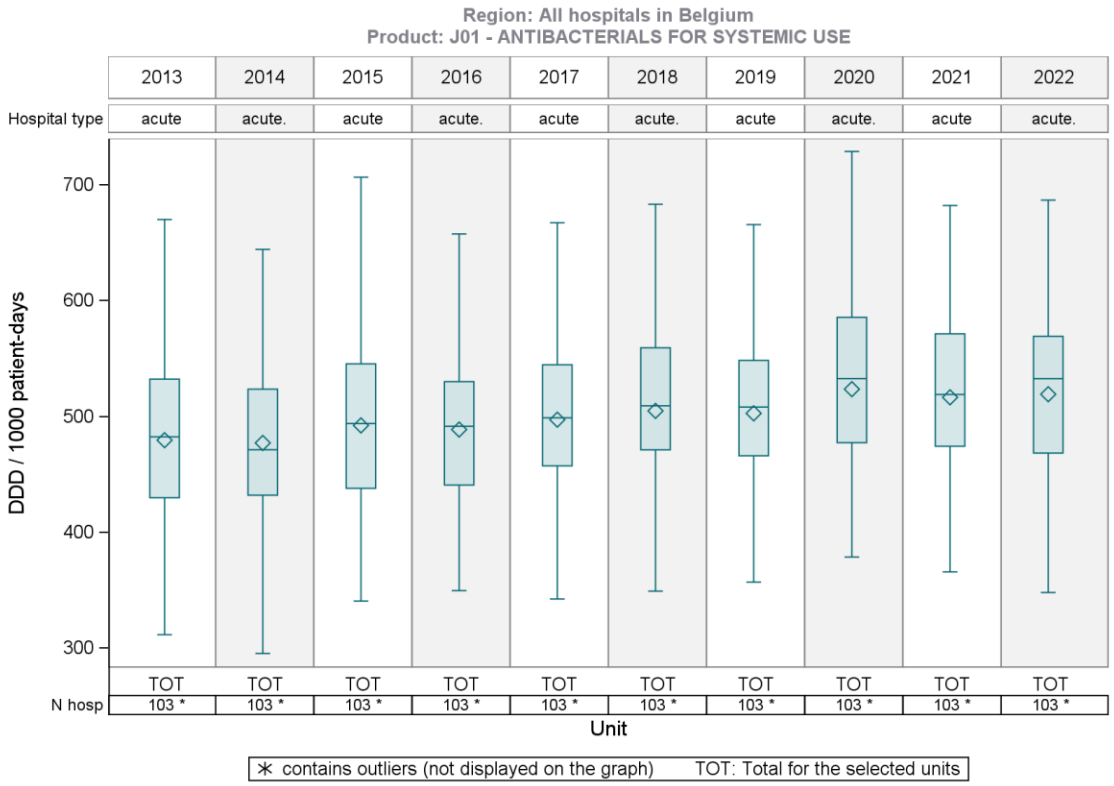
BeH-SAC – Belgian Hospital Surveillance of Antimicrobial Consumption 2013-2022



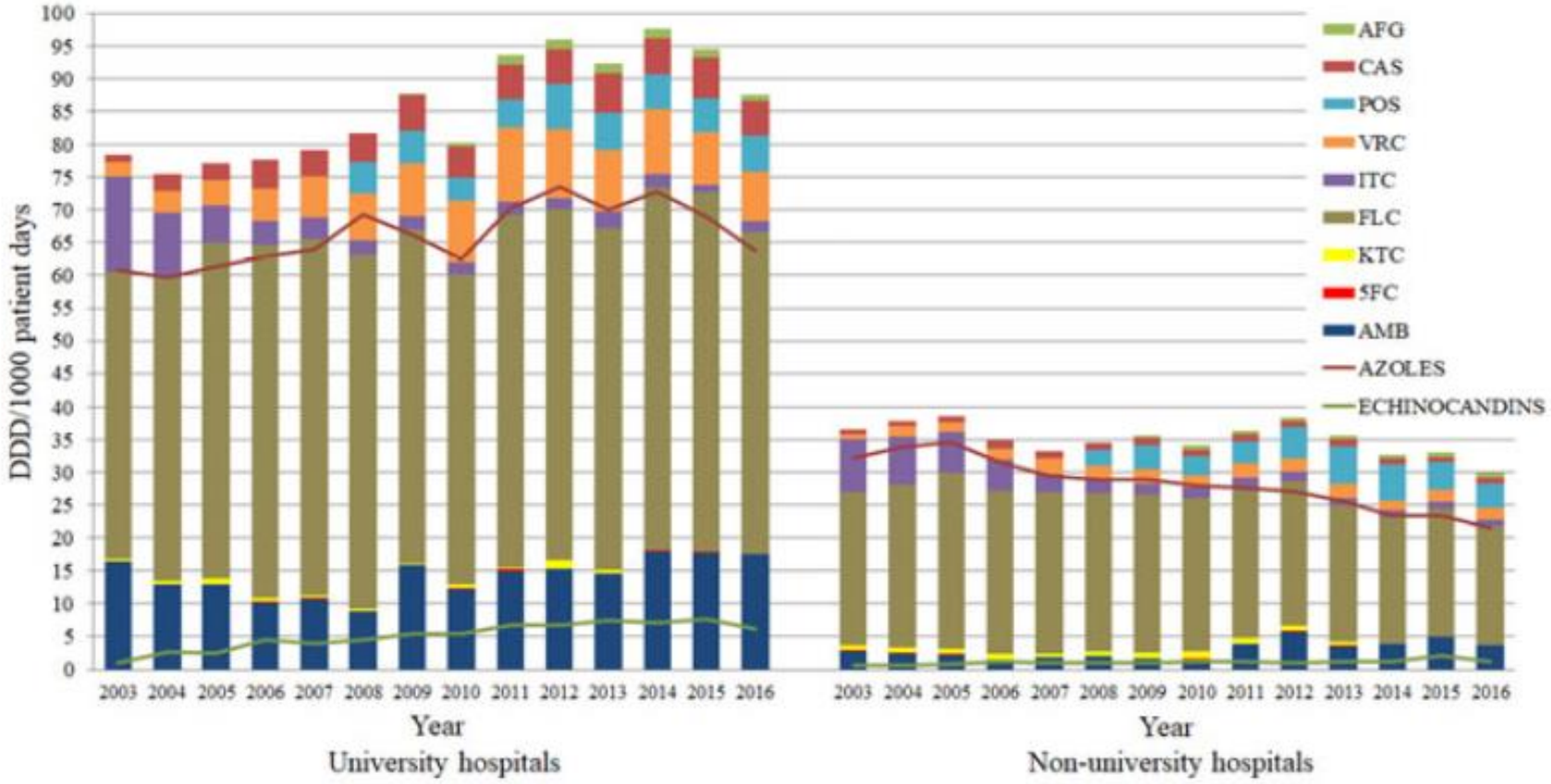
- Increasing trend **(+10.4%)** between 2013 and 2022. (Not statistically significant)

Belgian Hospitals • Surveillance of Antimicrobial Consumption

Causal relationships treatment incidence & resistance

- MacDougall C, Harpe SE, Powell JP, Johnson CK, Edmond MB, Polk RE. Pseudomonas aeruginosa, Staphylococcus aureus, and fluoroquinolone use. Emerg Infect Dis. 2005 Aug;11(8):1197-204. doi: 10.3201/eid1108.050116. PMID: 16102307; PMCID: PMC3320507
- Lafaurie M, Porcher R, Donay JL, Touratier S, Molina JM. Reduction of fluoroquinolone use is associated with a **decrease** in methicillin-resistant Staphylococcus aureus and fluoroquinolone-resistant Pseudomonas aeruginosa isolation rates: a 10 year study. J Antimicrob Chemother. 2012 Apr;67(4):1010-5. doi: 10.1093/jac/dkr555. Epub 2012 Jan 11. PMID: 22240401.
- Qu X, Wang H, Chen C, Tao Z, Yin C, Yin A, Ma C, Idris A. Surveillance of carbapenem-resistant Klebsiella pneumoniae in Chinese hospitals - A five-year retrospective study. J Infect Dev Ctries. 2019 Dec 31;13(12):1101-1107. doi: 10.3855/jidc.11798. PMID: 32088697.
- Ortiz-Brizuela E, Caro-Vega Y, Bobadilla-Del-Valle M, Leal-Vega F, Criollo-Mora E, López Luis BA, Esteban-Kenel V, Torres-Veintimilla E, Galindo-Fraga A, Olivas-Martínez A, Tovar-Calderón E, Torres-González P, Sifuentes-Osornio J, Ponce-de-León A. The influence of hospital antimicrobial use on carbapenem-non-susceptible Enterobacterales incidence rates according to their mechanism of resistance: a time-series analysis. J Hosp Infect. 2020 Aug;105(4):757-765. doi: 10.1016/j.jhin.2020.06.019. Epub 2020 Jun 18. PMID: 32565368.
- Almeida VF, Dantas RC, Ferreira ML, Urzedo JE, Almeida Junior ER, Royer S, Gontijo-Filho PP, Ribas RM. Relationship between antimicrobial use and the highest number of multidrug-resistant-Pseudomonas aeruginosa: a 10-year study. J Infect Dev Ctries. 2024 Aug 31;18(8):1227-1232. doi: 10.3855/jidc.18400.

Antimycotic use 2003-2016 Belgium Hospitals stratified by type



Goemaere et al., Mycosis 2019

BELGIAN COMMUNITY SECTOR

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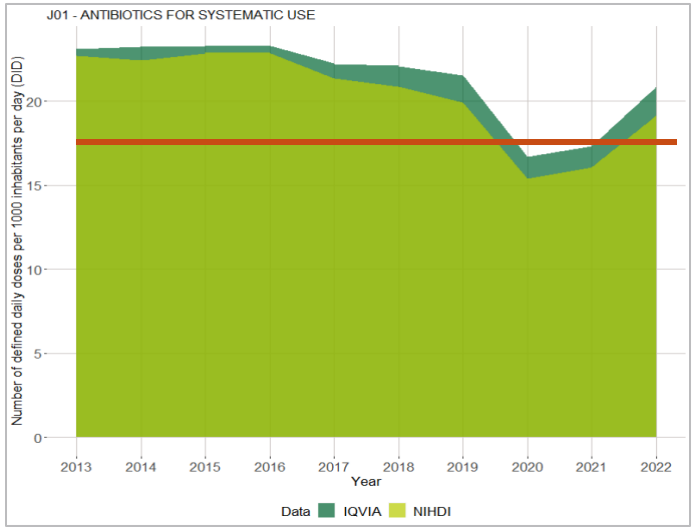
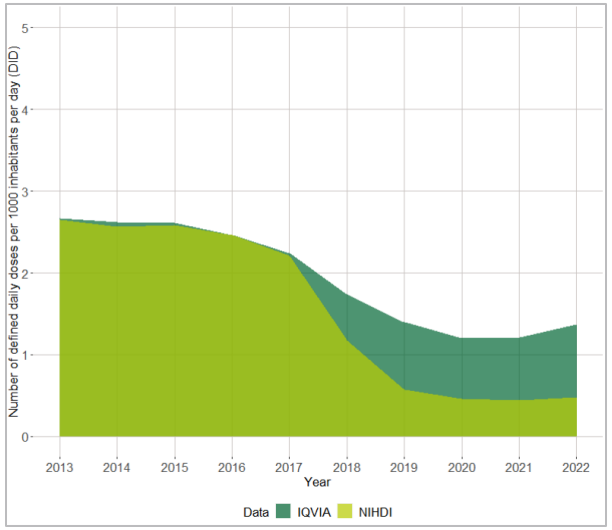
Evolution of reimbursement (NIHDI) and sales (IQVIA) data in the Belgian community sector

J01



J01M



Estimates (J01)	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
ESAC-Net DID	22.69	22.45	22.86	22.87	21.37	20.87	19.93	15.39	16.07	19.15
IQVIA DID	23.10	23.26	23.27	23.31	22.23	22.10	21.54	16.69	17.34	20.85
Relative difference (%)	1.82	3.64	1.77	1.94	4.04	5.89	8.08	8.48	7.90	8.91

J Antimicrob Chemother
https://doi.org/10.1093/jac/dkae384

Journal of Antimicrobial Chemotherapy

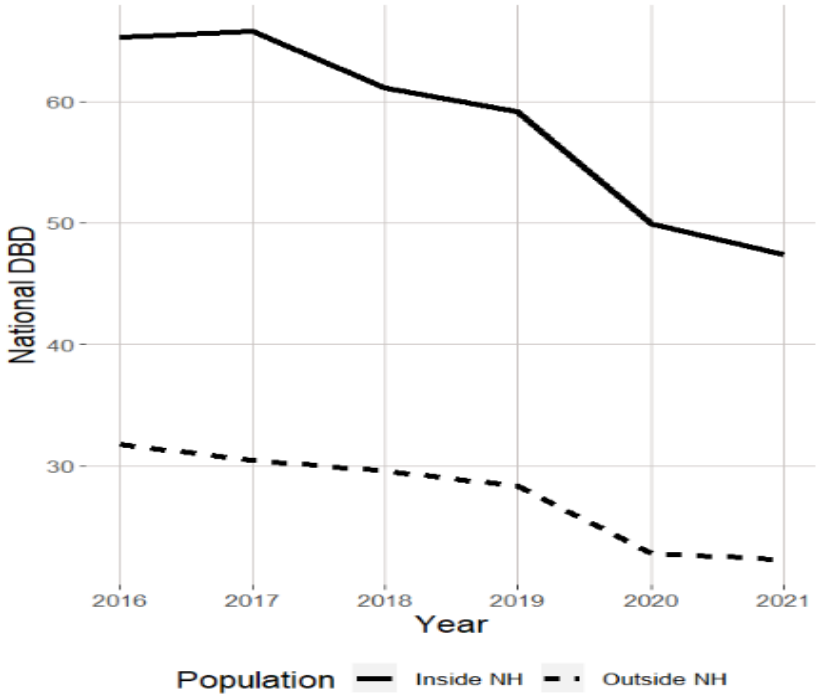
Monitoring community antibiotic consumption in Belgium: reimbursement versus retail data (2013–22)

Elena Damian [1*], Laura Bonacini[1], Moira Kelly[1], El Maati Allaoui[2], Charline Maertens De Noordhout[3], Samuel Coenen [4,5], Ivo Deckers[6,7], Sarah De Clercq[8], Marc De Falleur[9], Ann Versporten[6,7,10], Boudewijn Catry[1,11] and Lucy Catteau[1,12]

Damian et al., 2024

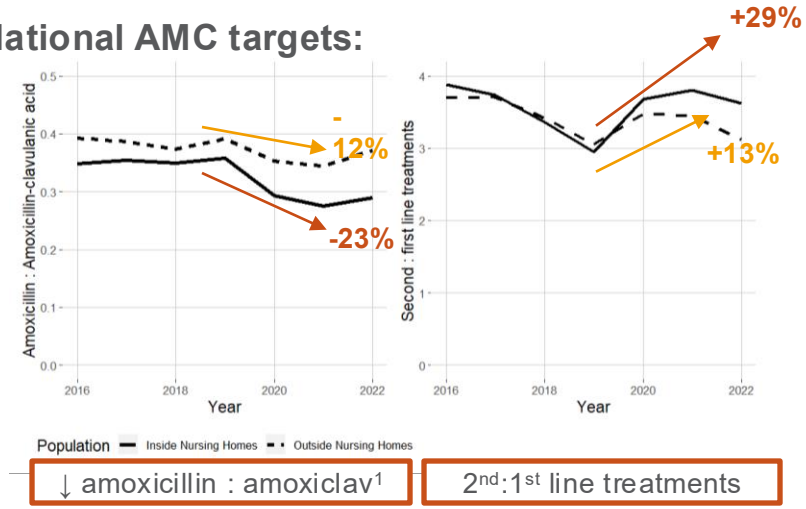
AMC Surveillance in Belgian Nursing homes

Total consumption of J01 in the 65+ age group



DBD = DDD per Beneficiary per 1000 days

National AMC targets:



↓ amoxicillin : amoxiclav[1]

2nd:1st line treatments

SURVEILLANCE

Antibiotic consumption patterns in older adults: a comparative study of people 65 years and older in and outside nursing homes, Belgium, 2016 to 2022

Moira Kelly[1], Marc de Falleur[2], El Maati Allaoui[3], Laura Bonacini[1], Boudewijn Catry[1,4], Katrien Latour[1], Lucy Catteau[1,5]

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Article received on 06 Mar 2024 / Accepted on 08 Jul 2024 / Published on 14 Nov 2024

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How is the EU progressing towards the 2030 antimicrobial resistance targets?

Reduce by 20% the total consumption of antibiotics in humans As defined daily doses (DDD) per 1 000 inhabitants per day	2019 Baseline	19.9	-
	2022	19.4	-2.5%
	2030 TARGET	15.9	-20%
At least 65% of the total consumption of antibiotics in humans belongs to the 'Access' group of antibiotics As defined in the AWaRe classification of the WHO *Population-weighted mean % consumption in 'Access' group. **Percentage point difference from 2019.	2019 Baseline	61.1%*	-
	2022	59.8%*	-1.3%**
	2030 TARGET	65%	+3.9%**
Reduce by 15% the total incidence of bloodstream infections with meticillin-resistant *Staphylococcus aureus* (MRSA) Number per 100 000 population	2019 Baseline	5.6	-
	2022	4.9	-12.2%
	2030 TARGET	4.8	-15%
Reduce by 10% the total incidence of bloodstream infections with third generation cephalosporin-resistant *Escherichia coli* Number per 100 000 population	2019 Baseline	10.4	-
	2022	8.7	-16.8%
	2030 TARGET	9.4	-10%
Reduce by 5% the total incidence of bloodstream infections with carbapenem-resistant *Klebsiella pneumoniae* Number per 100 000 population	2019 Baseline	2.2	-
	2022	3.3	+49.7%
	2030 TARGET	2.1	-5%

amr-brief-eaad-2023-update.pdf

EU 2030 Targets in Belgian elderly

Table. Percentage of World Health Organisation AWaRe-classified J01 antibiotics for the population ≥65 years inside and outside nursing homes, Belgium, 2016–2021.

Category	Setting	2016	2017	2018	2019	2020	2021
Access	Inside nursing homes	64.7%	63.7%	66.9%	70.3%	70.4%	70.4%
	Outside nursing homes	60.6%	60.4%	64.2%	66.4%	66.6%	67.4%
Watch	Inside nursing homes	31.3%	32.3%	28.8%	25.2%	24.6%	23.9%
	Outside nursing homes	37.3%	37.5%	33.5%	31.3%	30.7%	29.7%
Reserve	Inside nursing homes	3.9%	4.0%	4.3%	4.5%	5.0%	5.7%
	Outside nursing homes	2.1%	2.2%	2.3%	2.3%	2.8%	2.9%

Open in a new tab

AWaRe: Access, Watch or Reserve.

Kelly et al., 2025

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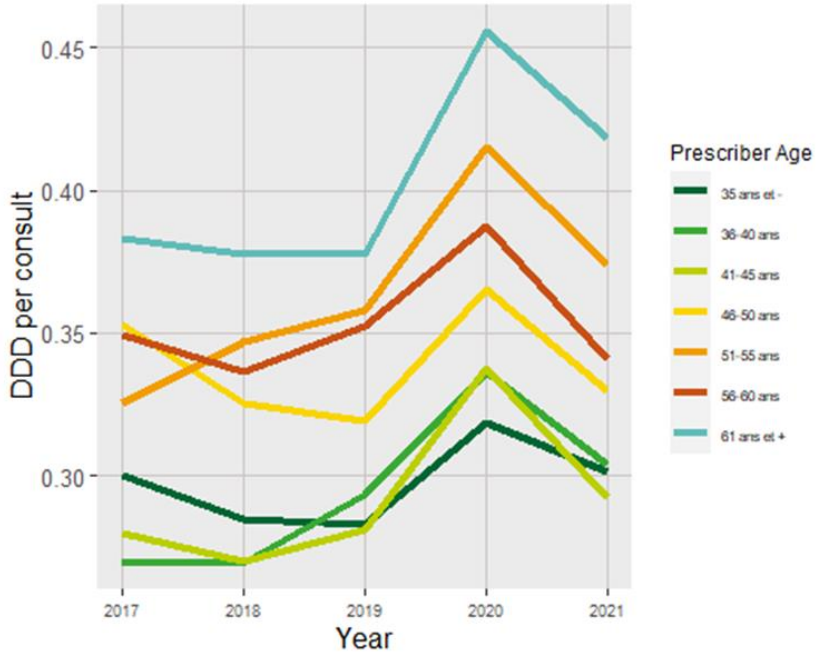
Prescribing behaviour

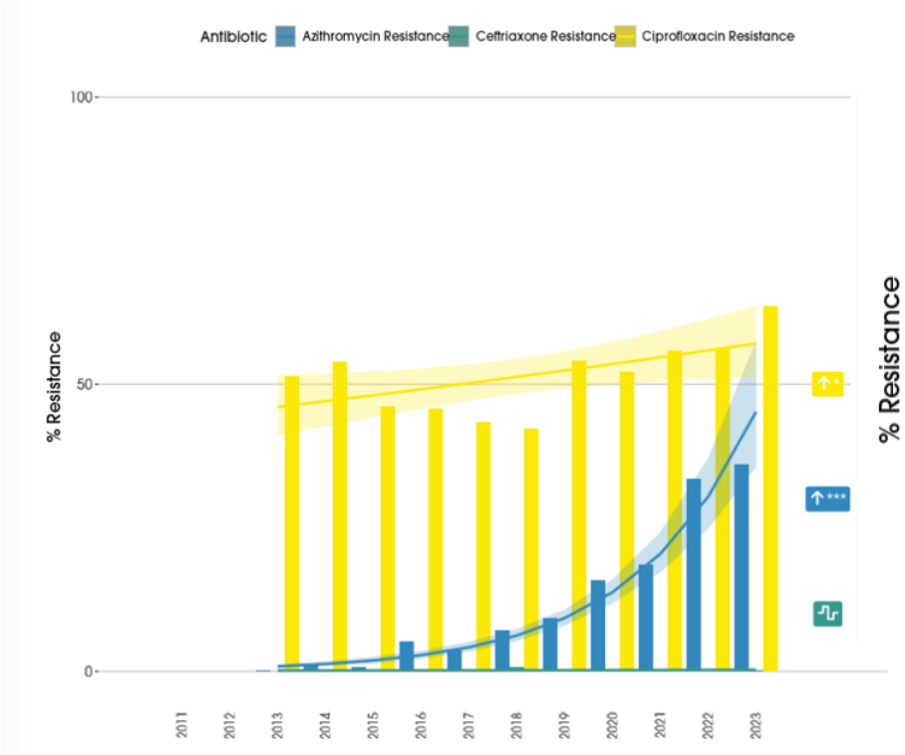
- Focus on main AB prescribers: general practitioners and dentists
- Identify factors influencing prescription
- Example

J01 DDD prescribed per consultation by Belgian dentists, by age groups (2017-2021)

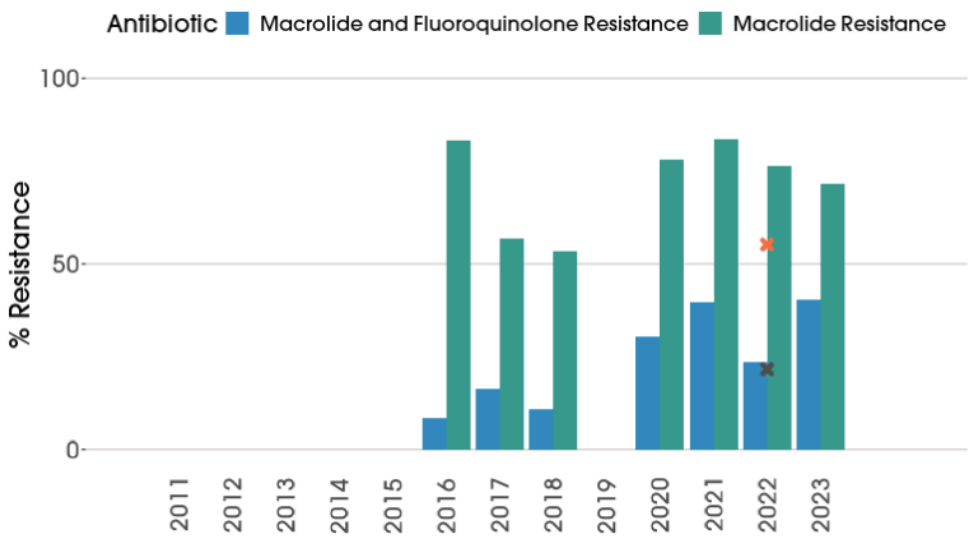


Work in progress…

In Belgium, worrying trends in antimicrobial resistance (AMR) are seen in bacterial sexually transmitted infections (STIs).



Neisseria gonorrhoeae



Mycoplasmoides genitalum

https://belmap2023.shinyapps.io/belmap2023_app

Concluding remarks

Monitoring selection pressure outcome:

- Hospitals
  - Gram-positives: vancomycine enterococci
  - Gram-negatives: Carbapenem resistance (extending carbapenemase + strains)
  - Other: Candida – co-infections

  Healthcare-associted infections: well monitored in Belgium
- Community: Sexually transmitted diseases, *Shigella*

  Future: genomic surveillance & outbreak mapping

Monitoring selection pressure primary risk factor

Treatment incidence (DDD/target/day)

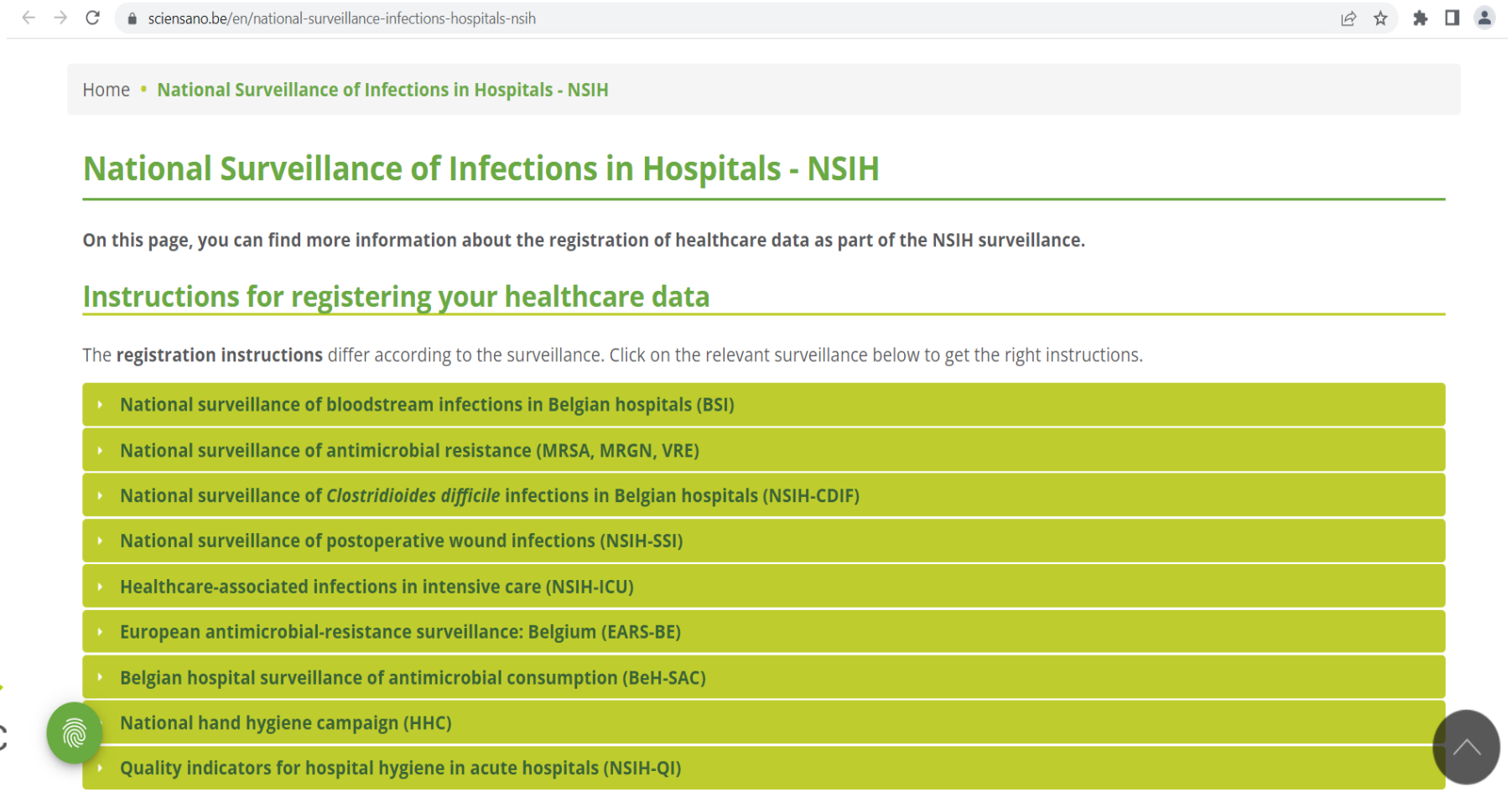
Target – variable & estimate of 'kg biomass'

- Hospitals: not in decline
- Community: in decline

  Future: coupling consumption & indication (APR-DRG)

Surveillance multidrug resistente organismen (MDRO)

https://www.sciensano.be/en/national-surveillance-infections-hospitals-nsih



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