Odpornost bakterij proti antibiotikom v Sloveniji in po svetu

doc. dr. Mateja Pirš, dr.med.

Inštitut za mikrobiologijo in imunologijo, UL MF

World Health Organization

GLASS
Global Antimicrobial Resistance and Use Surveillance System

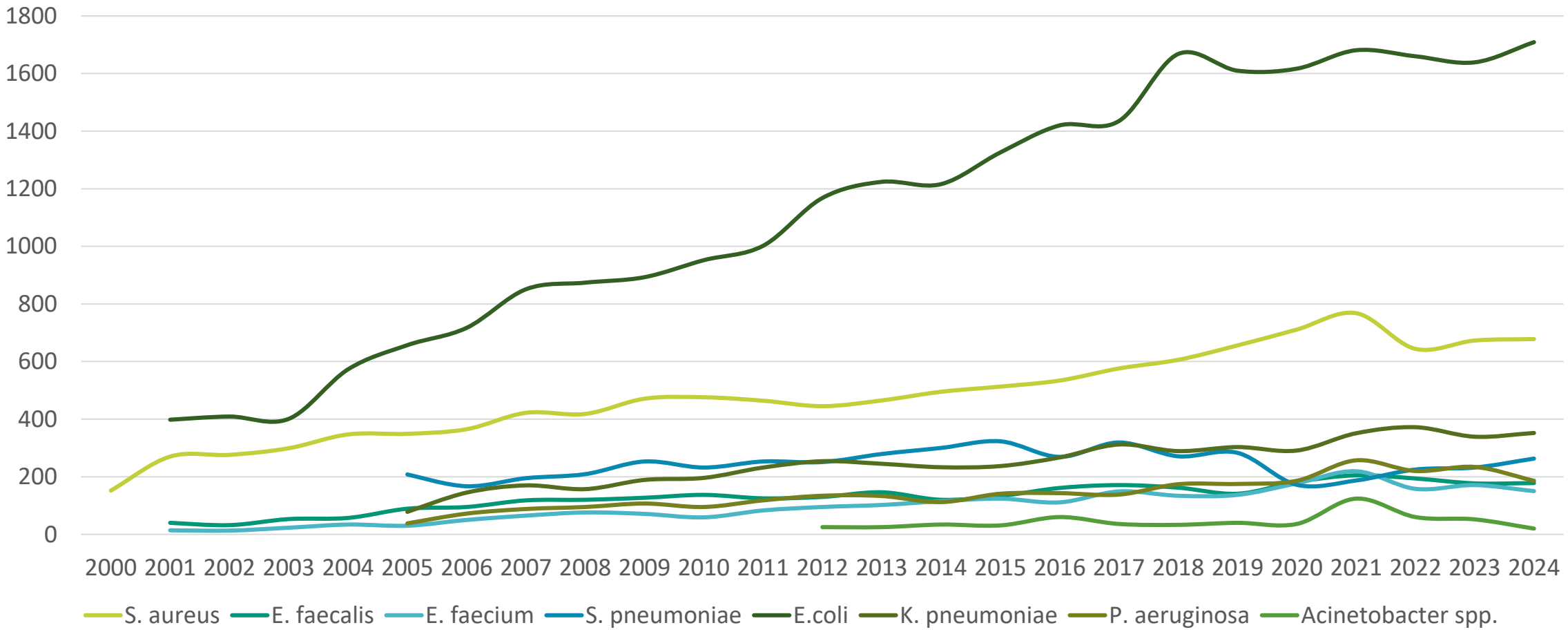
PubMed®

NIJZ Nacionalni inštitut za javno zdravje

Spremljanje nalezljivih bolezni

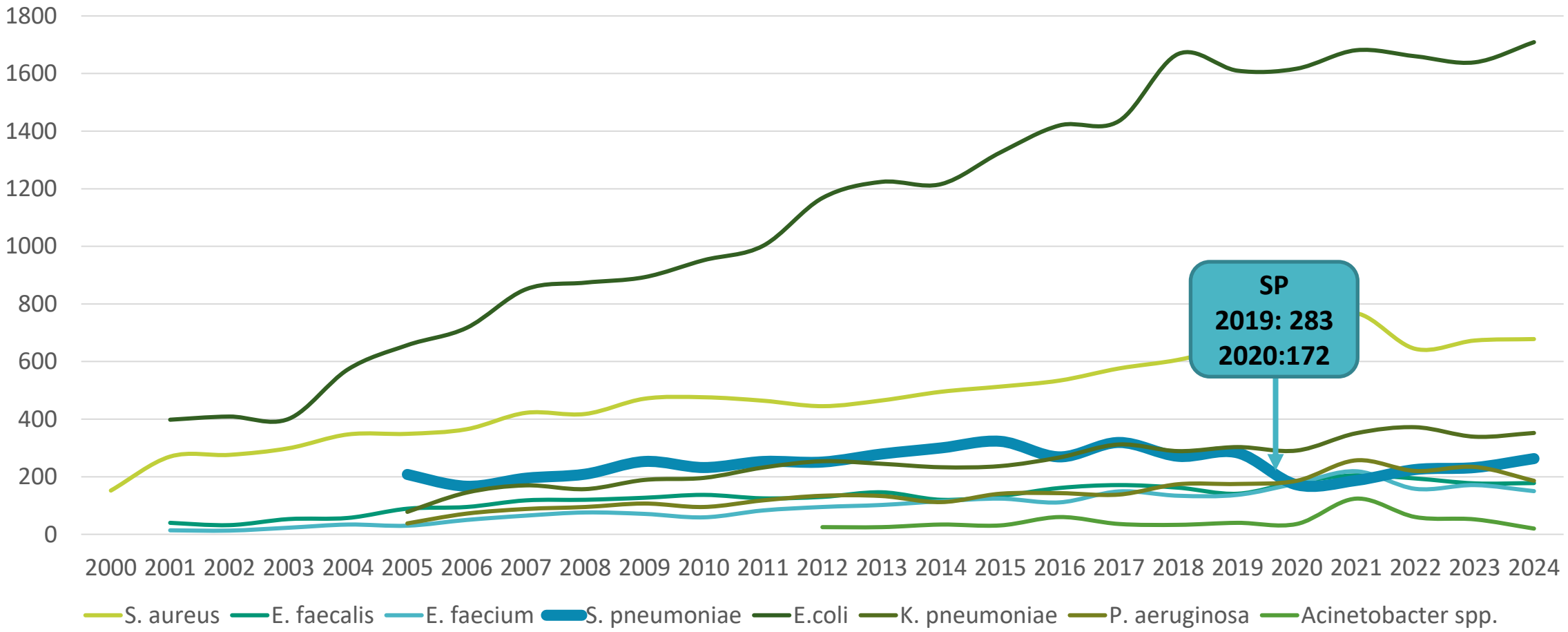
Slovenska komisija za ugotavljanje občutljivosti za protimikrobna zdravila

EARS-Net Slovenija – invazivni izolati (kri, likvor)



Blood-culture sets/1000 patient days	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
	35,1	35,0	41,2	36,8	40,4	47,1	56,1	56,4	44,7	66,8

EARS-Net Slovenija - *S. pneumoniae*



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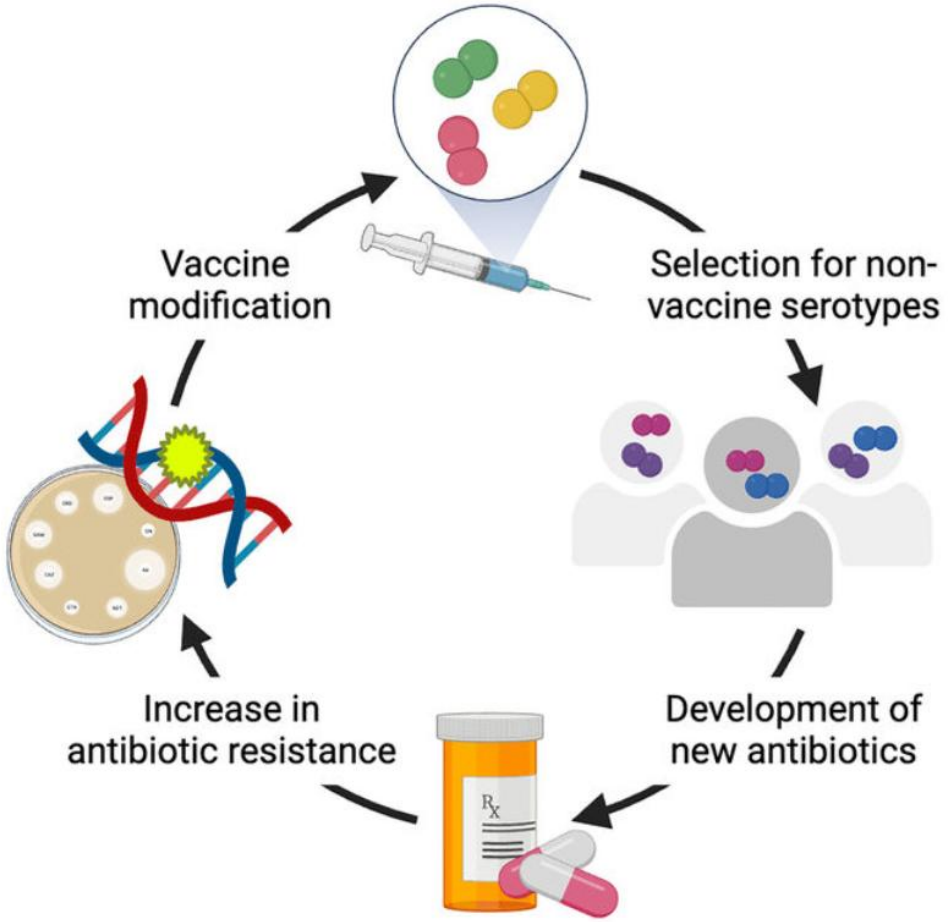
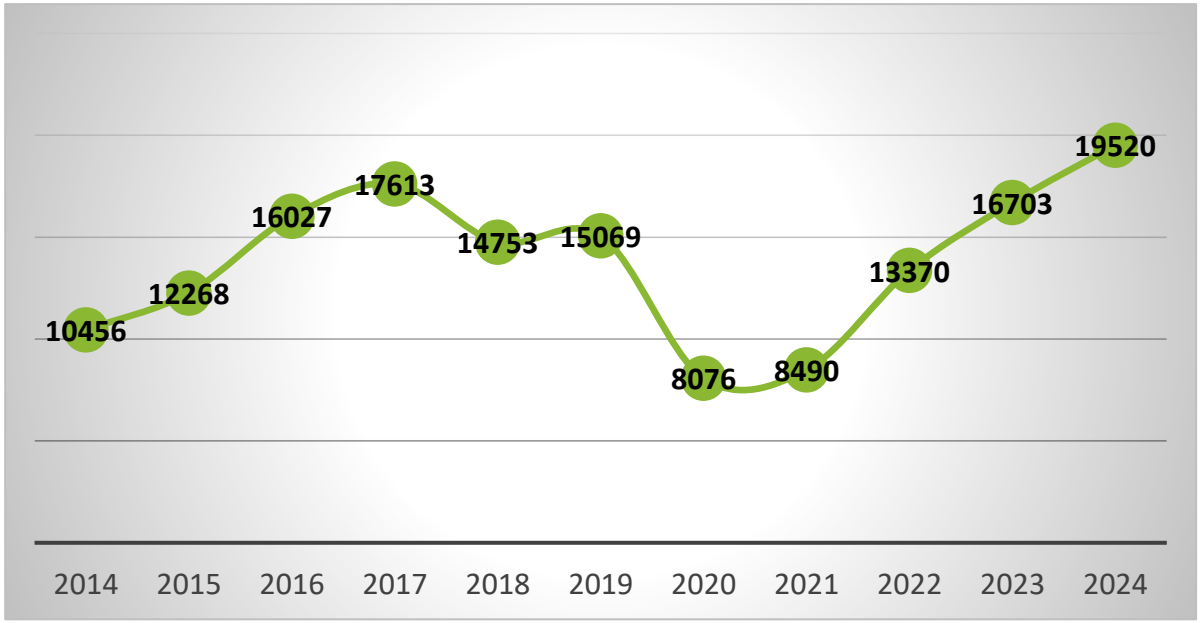
Convergent Impact of Vaccination and Antibiotic Pressures on Pneumococcal Populations

Cydney N. Johnson*,1, Shyra Wilde*,1, Elaine Tuomanen**,1, Jason W. Rosch**,1



- Kapsularno cepivo → spremembe v sestavi krožečih serotipov → spremembe rezistotipov krožečih serotipov
- Antibiotilni pritisk
- Obdobje **COVID-19 & nefarmakološki** ukrepi!



Convergent Impact of Vaccination and Antibiotic Pressures on Pneumococcal Populations

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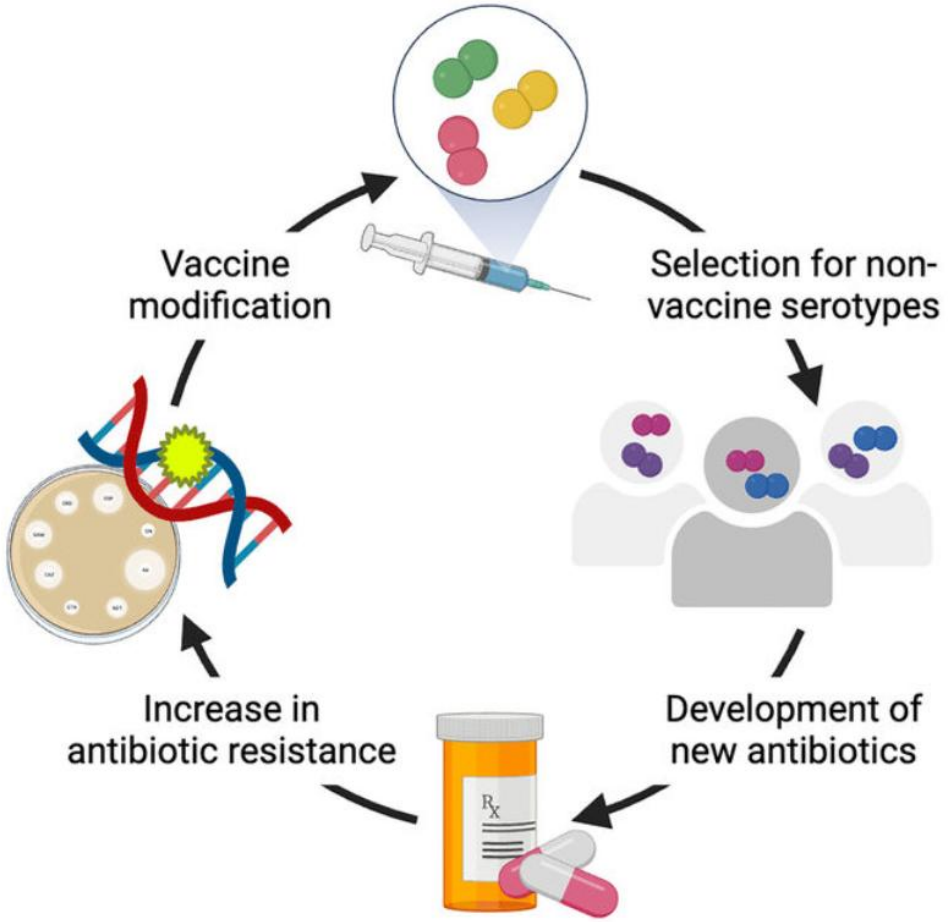

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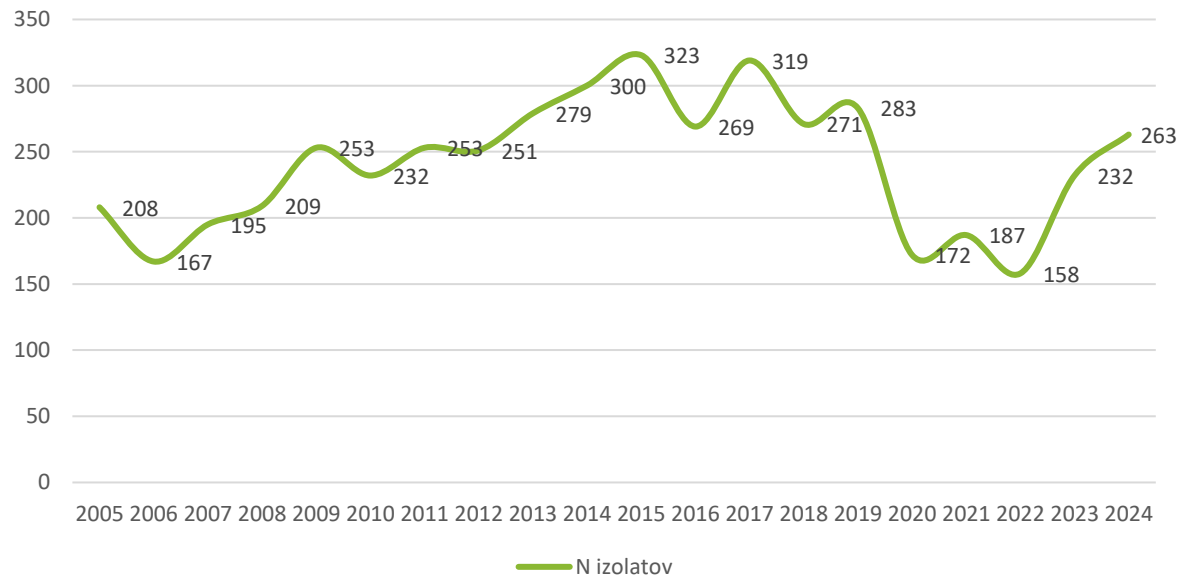
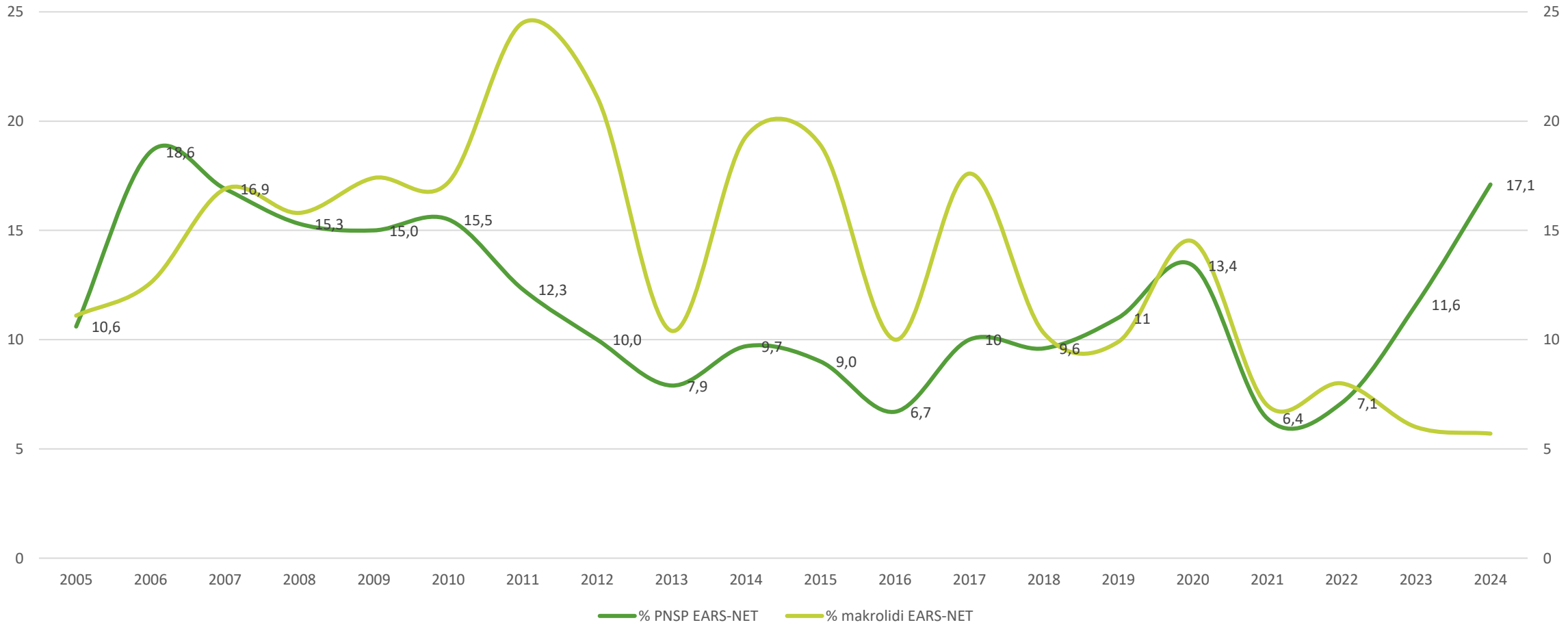
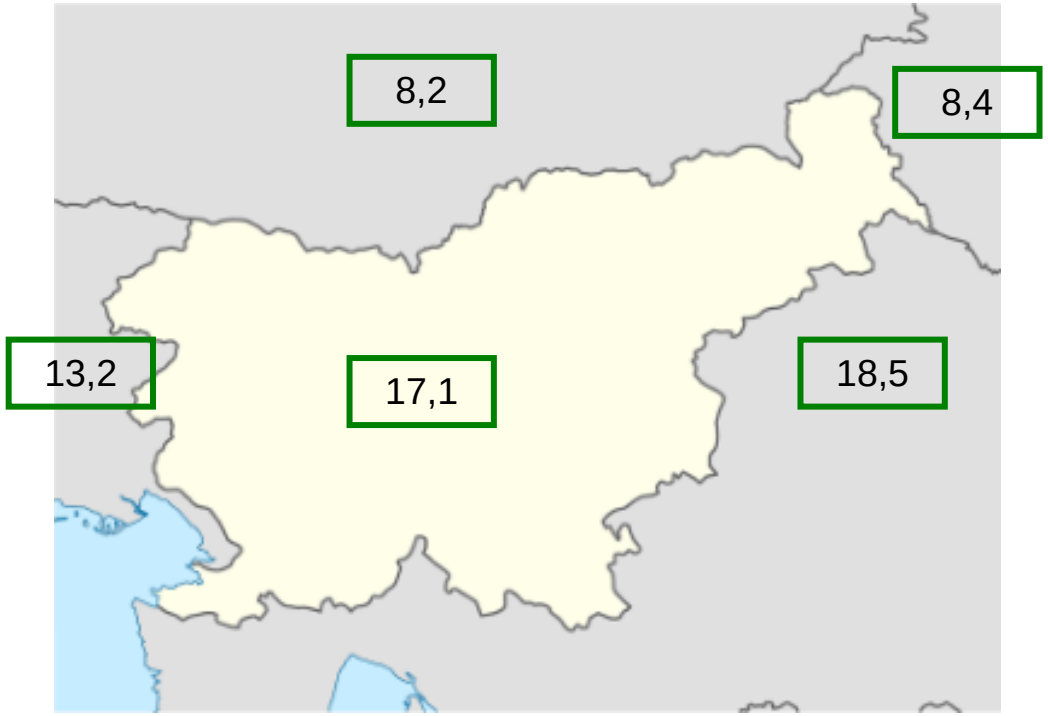


EARS-NET SLOVENIJA: http://www.nijz.si/sl/ears-net-slovenija
SKUOPZ: http://www.imi.si/strokovna-zdruzenja/skuopz/skuopz



Proti penicilinu odporni *S. pneumoniae* (PNSP)

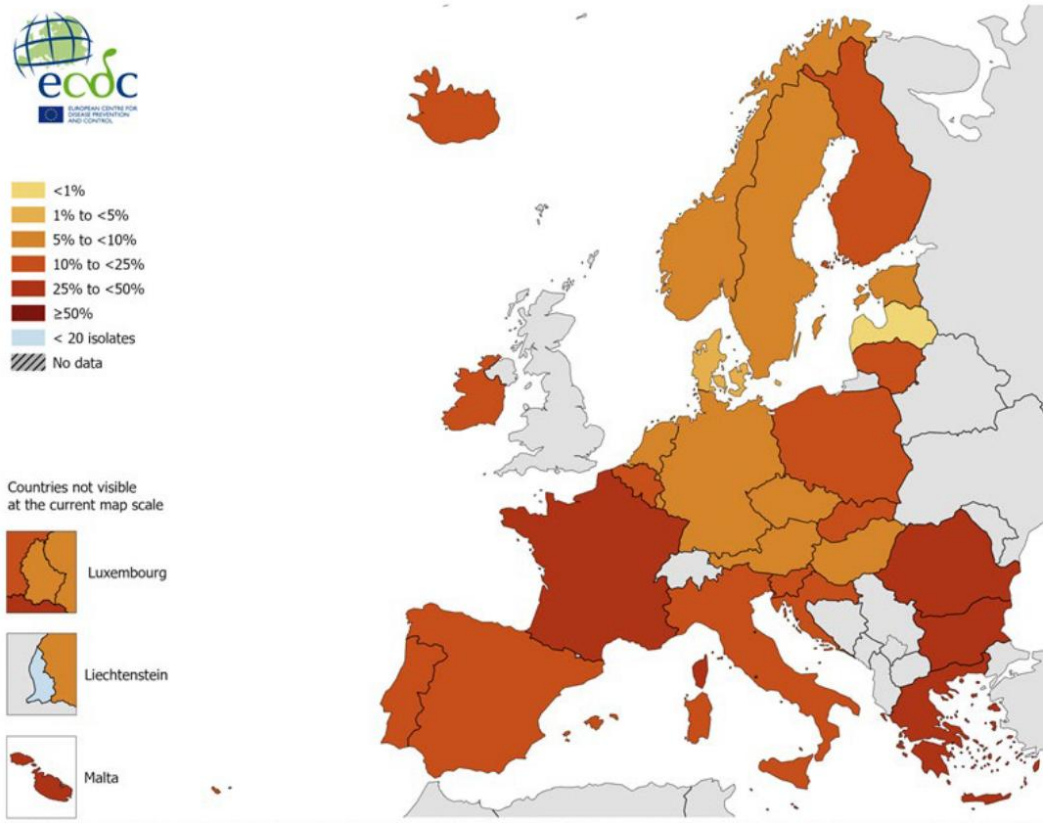
Lokalni podatki - EARS-Net 2024



ne „divji“ tip

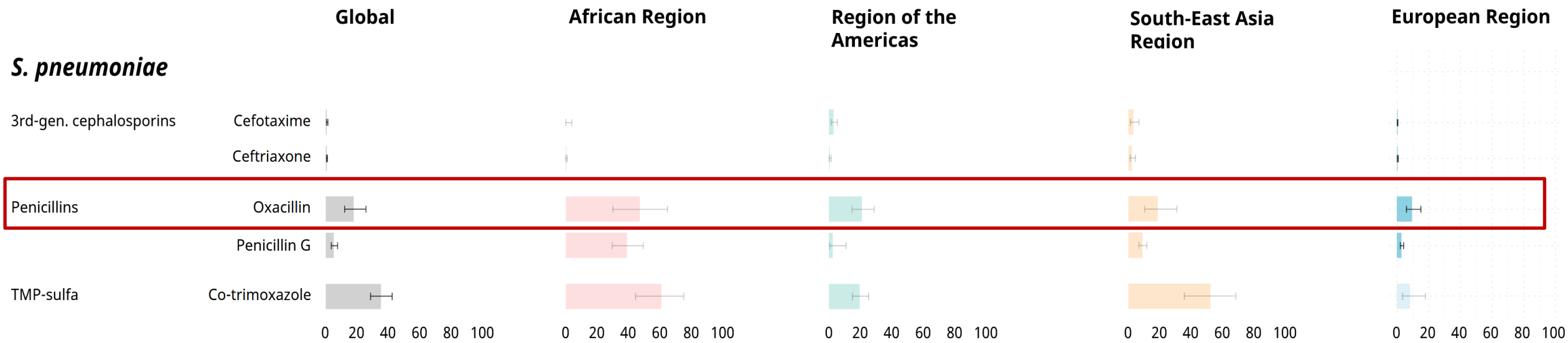
Bacterial species	Antimicrobial group/agent resistance	2018		2019		2020		2021		2022		2022 EU/EEA country range[b]	Trend 2018–2022[c]
		n	%	n	%	n	%	n	%	n	%		
Streptococcus pneumoniae	Penicillin non-wild-type[a]	14 498	14.0	14 568	13.2	8 076	15.5	8 479	16.2	13 230	16.3	2.8–46.7	↑*
	Macrolide (azithromycin/clarithromycin/erythromycin) resistance	14 753	16.6	15 069	15.9	8 407	16.8	8 773	18.3	13 947	17.9	3.4–36.1	↑*
	Combined penicillin non-wild-type and resistance to macrolides[a]	14 016	8.6	14 102	8.0	7 782	8.9	8 155	9.8	12 694	9.7	0.8–33.3	↑*

ECDC EARS-Net

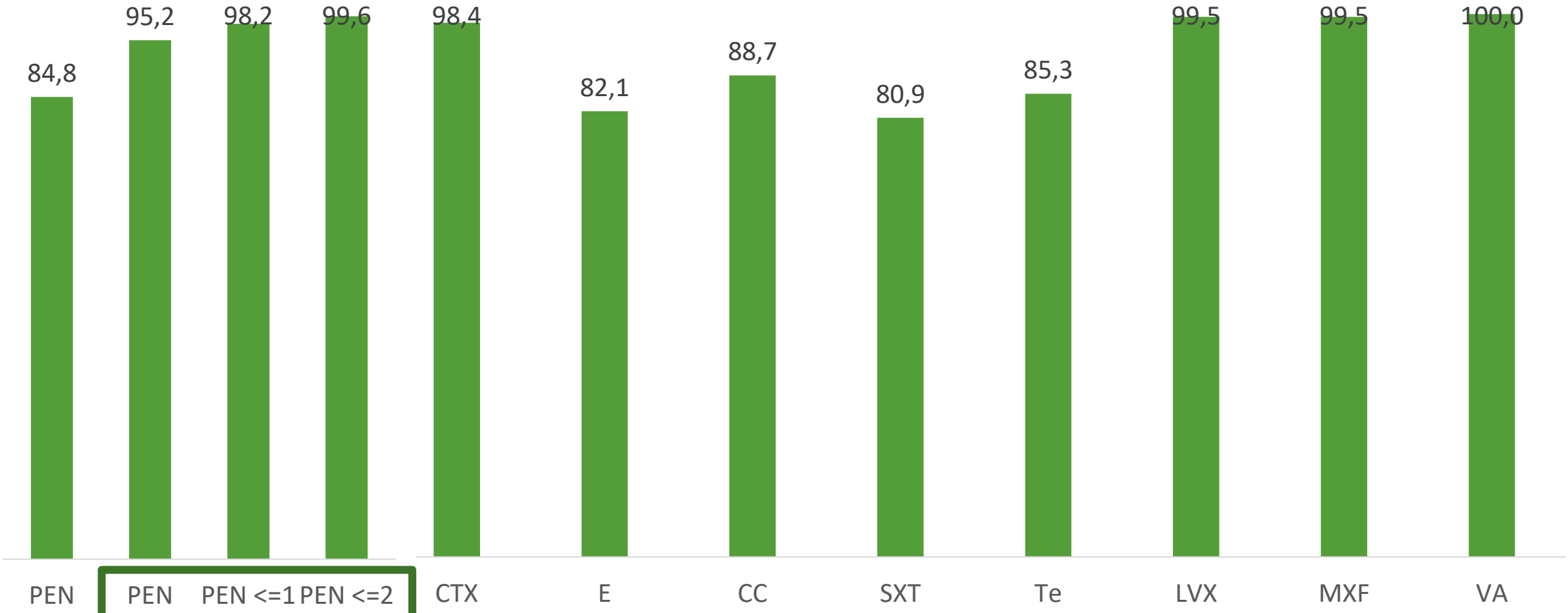


World Health Organization

Figure 3.1. Percentage AMR in bloodstream infections: global and regional estimates, 2023

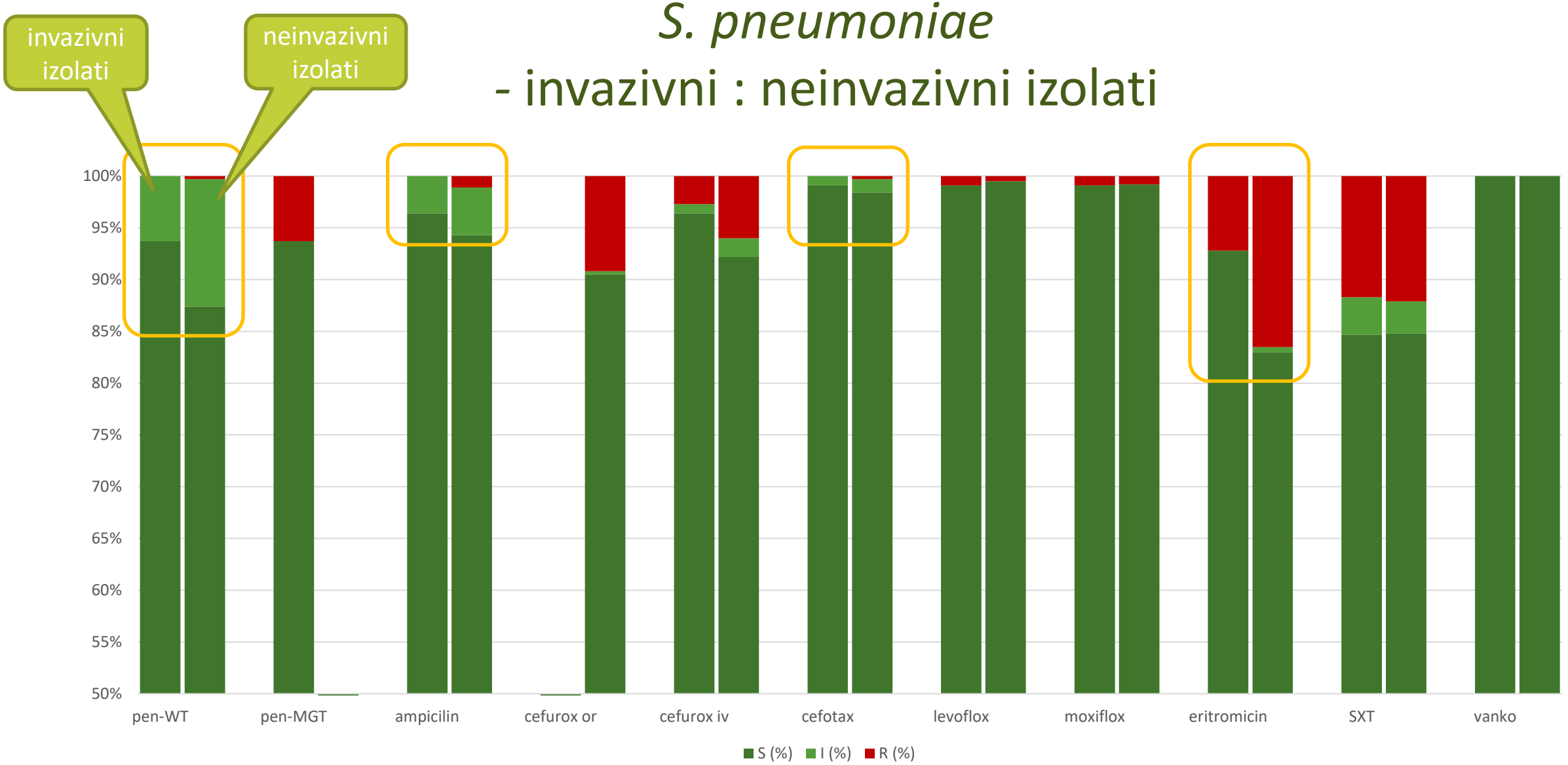


Streptococcus pneumoniae



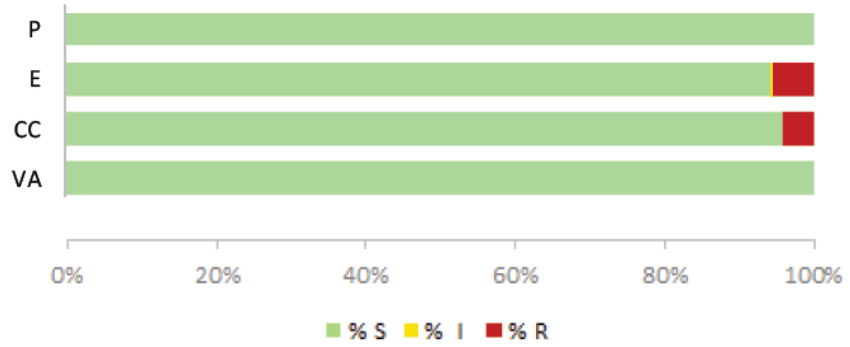
Vir: SKOUPZ

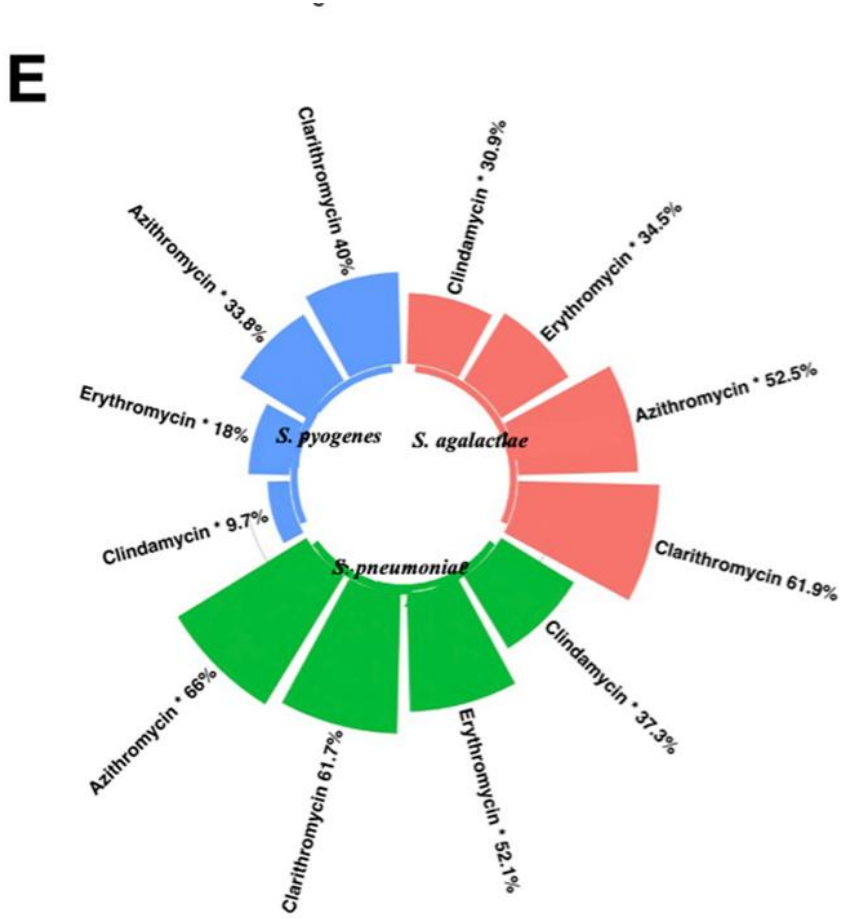
S. pneumoniae
- invazivni : neinvazivni izolati



Streptococcus pyogenes

- Odlična občutljivost za penicilin
- Občutljivost za eritromicin 94 %, za klindamicin 96 %.



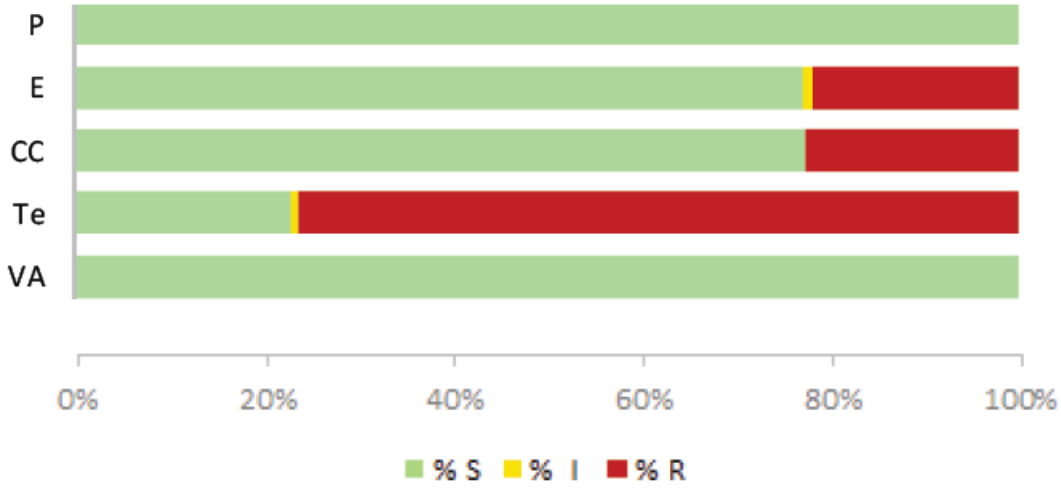


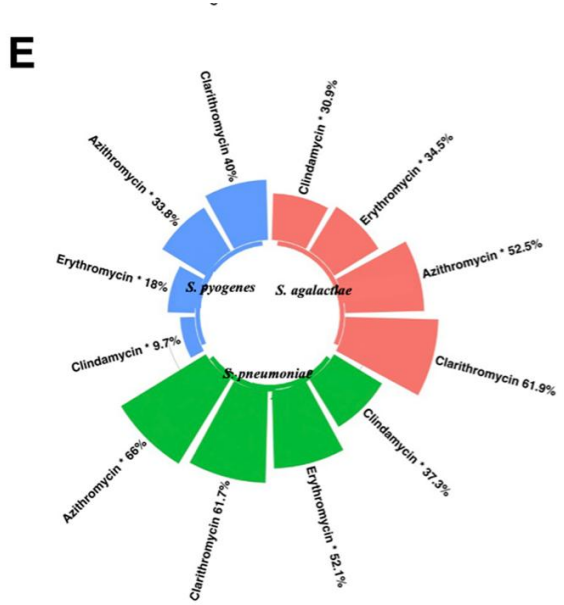
Shivaee et al. 2025

Streptococcus agalactiae

- Odlična občutljivost za penicilin

- Eritromicin: odpornost 12 - 50%,
- Klindamicin: odpornost 2 – 42%
- Tetraciklin: odpornost >80%





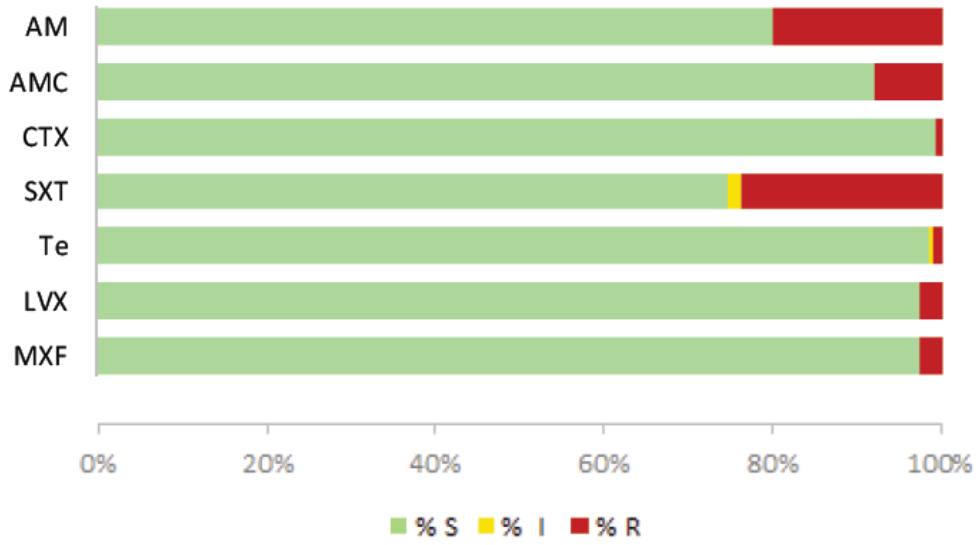
Shivaee et al. 2025

PR-GBS – posamezna poročila

Japonska 14% (seki 2015)
Indija 27 % (Verma 2023)
Nikaragua 52% (Aleman 2023)

Haemophilus influenzae

Antibiotik	Okrajšava	% S	% I	% R	Število prvih izolatov
Ampicilin	AM	80,0	/	20,0	1668
Amoksicilin s klavulansko ksl.	AMC	92,1	/	7,9	1668
Cefotaksim	CTX	99,1	0	0,9	1402
Trimetoprim-sulfametoksazol	SXT	74,7	1,6	23,8	1665
Tetraciklin	Te	98,6	0,4	1,1	1663
Levofloksacin	LVX	97,4	/	2,6	1326
Moksifloksacin	MXF	97,4	/	2,6	1629



Haemophilus influenzae

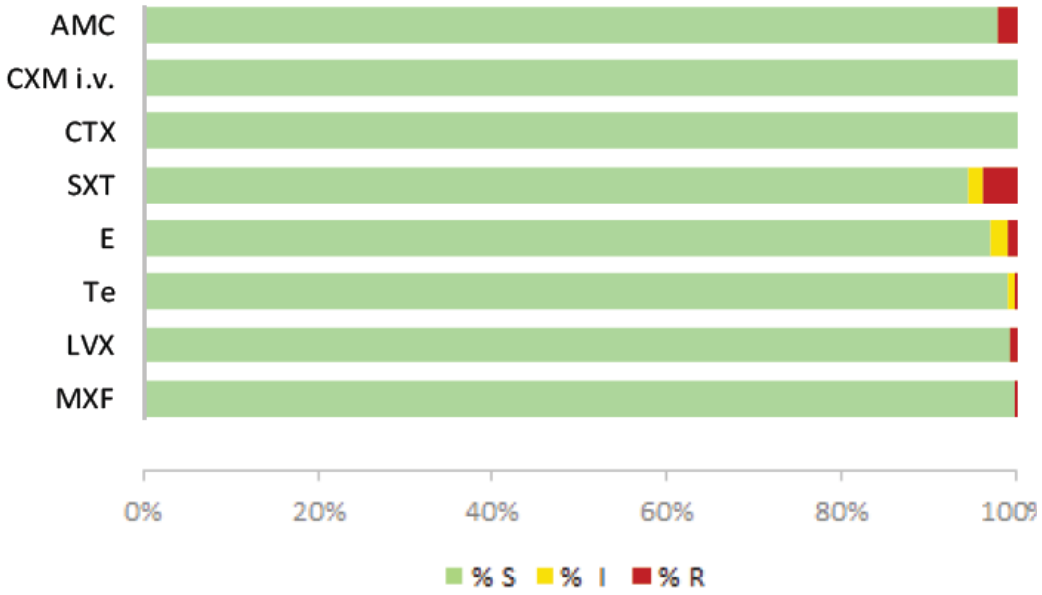
Antibiotic resistance and molecular characterization of non-invasive clinical *Haemophilus influenzae* isolates in Germany 2019 and 2020

Results: In total, 215 Hi isolates were collected from 23 laboratories across Germany. The highest resistance rates were found for amoxicillin ($n = 30$; 14%), cefuroxime ($n = 40$; 18.6%) and trimethoprim/sulfamethoxazole (co-trimoxazole) ($n = 34$; 15.8%). Resistance to amoxicillin was mainly due to bla_{TEM-1} ($n = 29$; 96.7%). PBP3 alterations were found in 39 of 40 cefuroxime-resistant isolates (97.5%). Two of the cefuroxime-resistant isolates harboured PBP3 mutation patterns that have not yet been associated with cefuroxime resistance; in one of them, a known *lpoA* mutation was found. One isolate showed no mutations in PBP3 or *lpoA*. All co-trimoxazole-resistant isolates (15.8%) showed known mutations in *folA* and its promoter region. Additionally, point mutations in *folP* were identified in a subset of these isolates. The most frequent sequence types (STs) were ST57 ($n = 10$) and ST103 ($n = 10$). Genetic cluster analysis identified six clusters, but no epidemiological link could be confirmed.

Conclusion: Resistance to oral antibiotics in non-invasive clinical Hi isolates in Germany was generally low. Amoxicillin is estimated to cover 86% of infections involving non-invasive Hi and, therefore, is still effective for the first-line empirical treatment for ENT infections in Germany. Further surveillance of antimicrobial susceptibility in non-invasive Hi isolates is important to ensure the data basis for guidelines of antibiotic usage.

Moraxella catarrhalis

Antibiotik	Okrajšava	% S	% I	% R	Število prvih izolatov
Ampicilin	AM	/	/	/	/
Amoksicilin s klavulansko ksl.	AMC	97,7	/	2,3	608
Cefuroksim i.v.	CXM i.v.	100	0	0	552
Cefotaksim	CTX	100	0	0	522
Trimetoprim-sulfametoksazol	SXT	94,2	1,8	3,9	608
Eritromicin	E	97,0	1,8	1,2	599
Tetraciklin	Te	99,0	0,8	0,2	608
Levofloksacin	LVX	99,2	/	0,8	497
Moksifloksacin	MXF	99,7	/	0,3	608



Mycoplasma pneumoniae

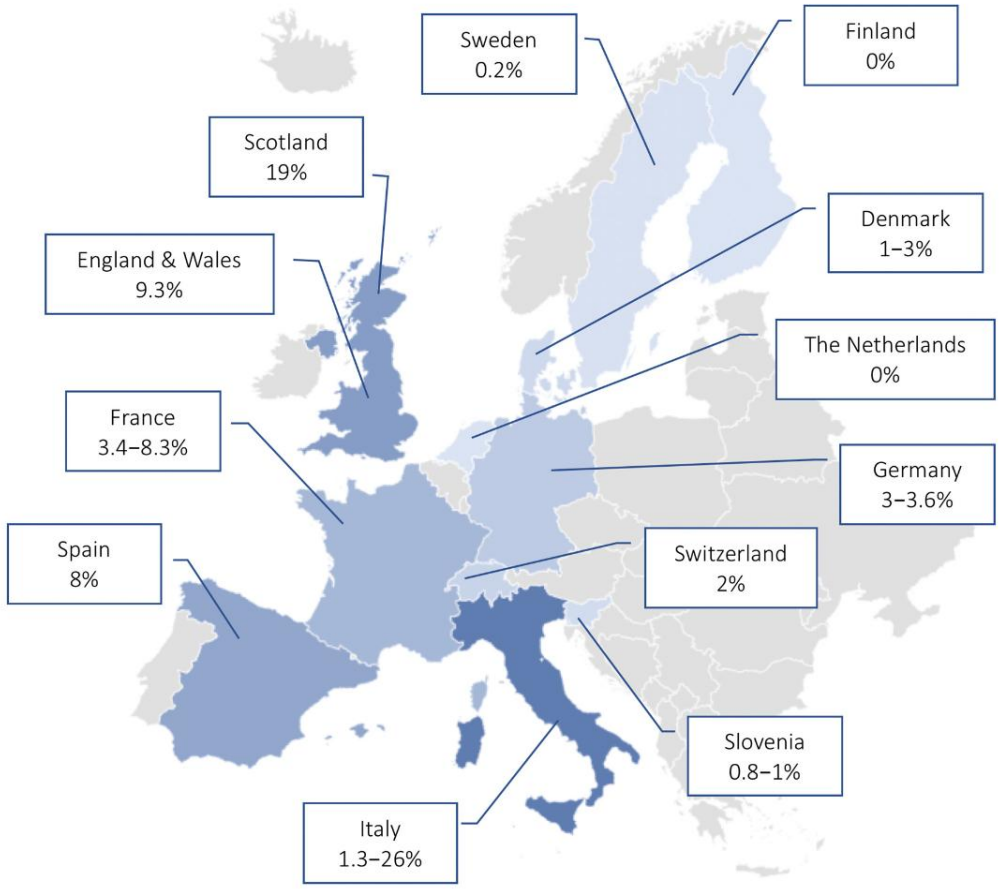


Figure 2. MR-MP prevalence rates reported in the European countries (years 1996–2019).

- Diagnostika okužb z mikoplazmo temelji na molekularni detekciji, določanje občutljivosti za antibiotike se ne izvaja rutinsko
- V Evropi od 0,2% do 26%
- Slovenija ≈ 1%

Genetic diversity and macrolide resistance of *Mycoplasma pneumoniae* isolates from two consecutive epidemics in Slovenia

R. Kogoj[1] · M. Praprotnik[2] · T. Mrvič[3] · M. Korva[1] · D. Keše[1]

Mycoplasma pneumoniae

Chih Cheng et. Al. International Journal of Antimicrobial Agents 64 (2024

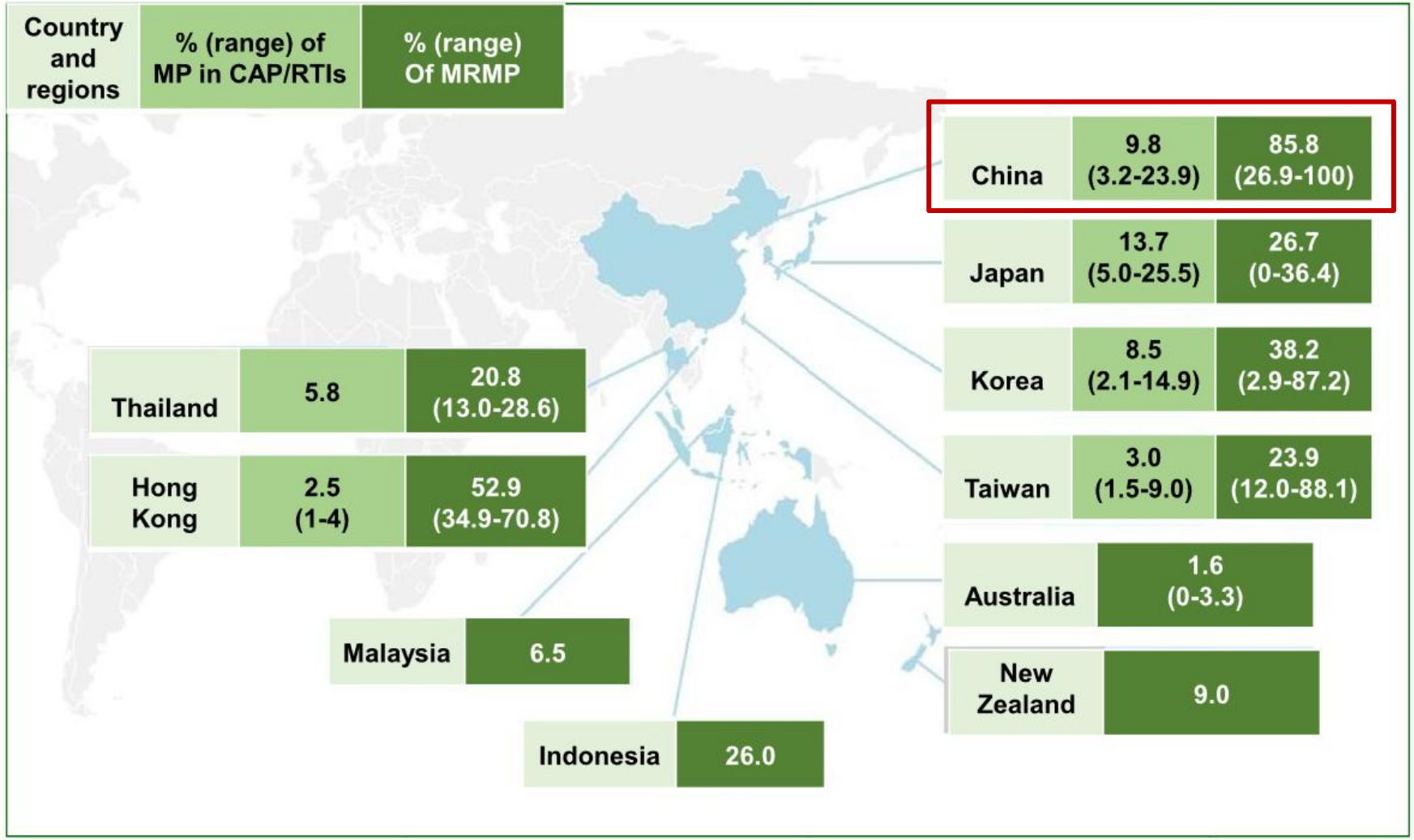


Figure 1. The positivity rate of *Mycoplasma pneumoniae* (MP) among patients with community-acquired pneumonia (CAP) or respiratory tract infections (RTIs), as well as the mean (range, %) proportion of macrolide resistance (MR) among MP (MRMP) isolates, in selected countries and regions in the Asia-Pacific region.

ESGMAC MAPS study group Lancet Microbe 2025:

The mean macrolide-resistant *M. pneumoniae* rate during the re-emergence for reporting sites was 2,02% (SD 1·35) in Europe (France, Belgium, England, Denmark, and Slovenia) and 71,22% (37·05) in Asia (China, South Korea, and Taiwan; table 3).

Bordetella pertussis

VIEWPOINT | VOLUME 8, 100098, MARCH 2021 Download Full Issue

Emerging macrolide resistance in *Bordetella pertussis* in mainland China: Findings and warning from the global pertussis initiative

Ye Feng • Cheng-Hsun Chiu • Ulrich Heininger • Daniela Flavia Hozbor • Tina Quanbee Tan • Carl-Heinz Wirsing von König

Open Access • Published: February 05, 2021 • DOI: https://doi.org/10.1016/j.lanwpc.2021.100098

Feng. Lancet Reg Health West Pac. 2021

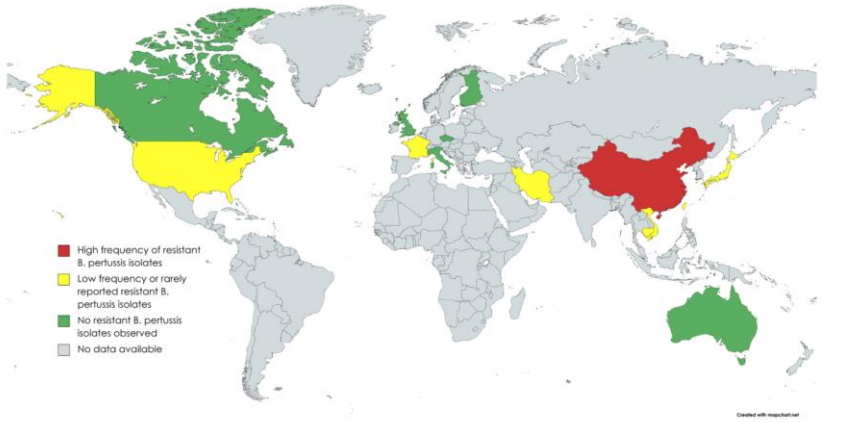


Figure 1. Countries where *B. pertussis* antimicrobial susceptibility studies have been performed

Ivaska. Antibiotics. 2022

Table 1. Global frequencies of macrolide-resistant *Bordetella pertussis*.

Country	Region/City	Year	Resistant Isolates Identified (Frequency %)	Reference
Australia	New South Wales, Perth	1971–2010	0/120 (0.0)	[24,25]
Cambodia	Whole country	2017–2020	1/71 (1.4)	[19]
Canada	Ontario	2011–2013	0/275 (0.0)	[26]
China	Xi'an	2012–2020	274/299 (91.6)	[27–31]
	Shandong	2011	2/2 (100.0)	[21]
	Northern	1970–2014 **	91/124 ** (91.9)	[22]
	Shanghai	2016–2017	81/141 (57.5)	[32]
	Zhejiang	2016–2020	271/381 (71.1)	[33–35]
	Beijing, Jinan, Nanjing, Shenzhen	2014–2016	292/335 (87.2)	[36]
	Midwest	2012–2015	163/167 (97.6)	[37]
	Whole country	1950–2018	316/388 (81.4)	[23]
	Hunan	2017–2018	27/55 (49.1)	[38]
	Shenzhen	2015–2017	51/105 (48.6)	[39]
	Whole country	2017–2019	265/311 (85.2)	[40]
Czech republic	Whole country	1967–2015	0/135 (0.0)	[41]
Finland	Whole country	2006–2017	0/148 (0.0)	[42]
France	Bordeaux & Lyon	2003 and 2012	1/41 (2.4)	[10,11]
Iran	Whole country	2009–2010	2/11 (18.2)	[16,43]
Italy	Rome	2012–2015	0/18 (0.0)	[44]
Japan	Whole country	2017–2019	1/33 (3.0)	[17,19]
Taiwan	Whole country	2003–2007	2/76 (2.6)	[19,23]
United Kingdom	Whole country	2001–2009	0/582 (0.0)	[45]
United States	Colorado, Maryland, Oklahoma, Wisconsin	1986	0/75 (0.0)	[46]
	Arizona—Yuma County	1994	1/1 (100.0)	[47]
	Utah	1985–1997	1/47 (2.1)	[12]
	Northern California	1998–1999	0/36 (0.0)	[48]
	Phoenix, Oakland *, San Diego	N/A ***	1/48 (2.1)	[49]
	California, New York, Minnesota, Massachusetts, Illinois, Arizona, Georgia	1994–2000	5/1030 **** (0.5)	[13]
	Minnesota	1997–1999	1/8 (12.5)	[50]
Vietnam	Hanoi, Ha Nam, Thai Binh	2016–2020	24/184 (13.0)	[18,19]

Mycobacterium tuberculosis

EU 2022 803 primeri MDR TB

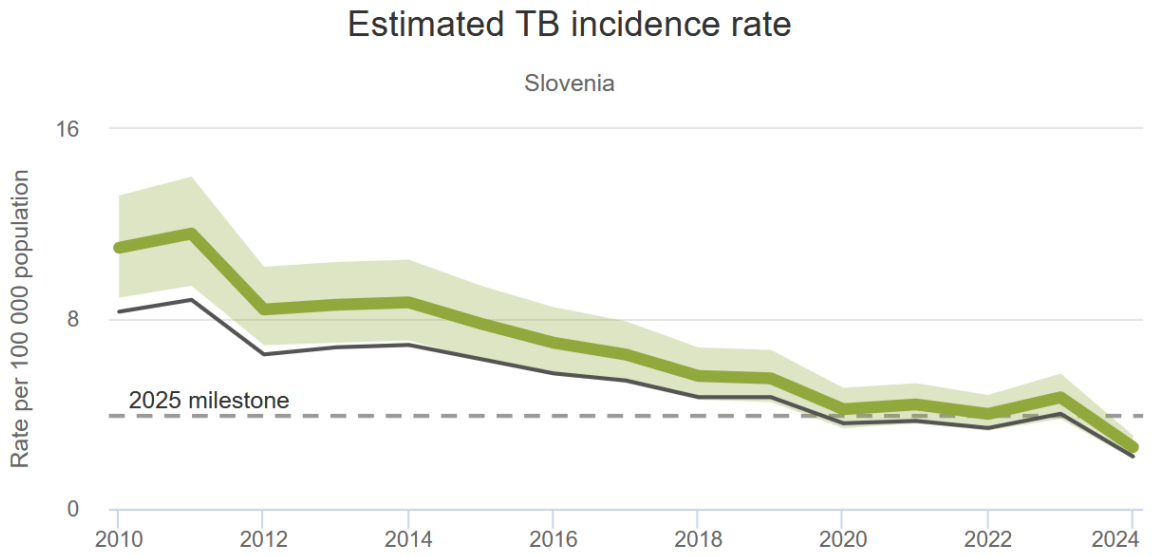
- Večkratno odporni sevi so velik svetovni problem
- Slovenija:
  - Občutljivost za vsa ključna zdravila že nekaj let od 97 do 100 %.
  - Letno ≈1 primer MDR/RR TB

Estimates of TB burden

Estimates of TB burden are produced by WHO in consultation with countries. Ranges represent uncertainty intervals.

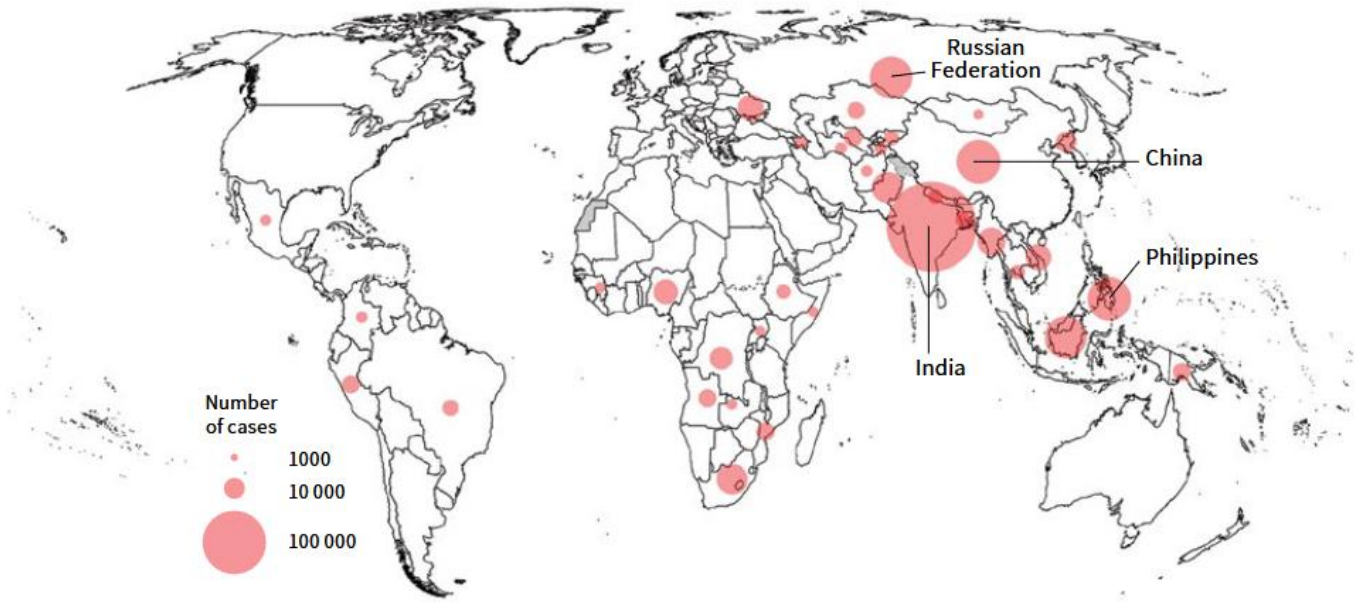
	Number	Rate per 100 000 population
Total TB incidence, 2024	54 (44–65)	2.6 (2.1–3.1)
TB incidence in people living with HIV, 2024	1 (0–6)	0.06 (0–0.27)
Multidrug-resistant or rifampicin-resistant TB (MDR/RR-TB) incidence, 2024	1 (0–1)	0.03 (0–0.05)
TB deaths in HIV-negative people, 2024	2 (2–2)	0.1 (0.1–0.11)
TB deaths in people with HIV, 2024	0 (0–1)	0.01 (0–0.05)

World Health Organization



Mycobacterium tuberculosis

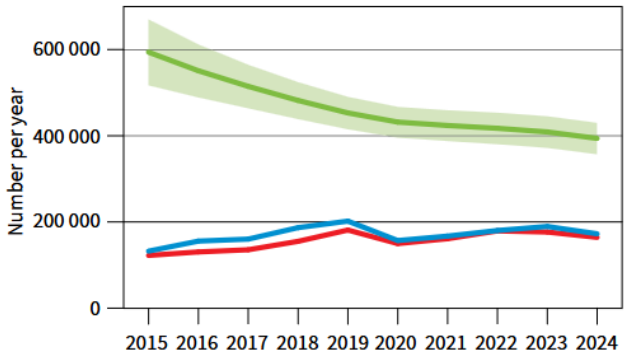
Estimated number of people who developed MDR/RR-TB (incident cases) for countries with at least 1000 incident cases, 2024[a]



[a] The labels show the four countries that accounted for more than half of the global number of people estimated to have developed MDR/RR-TB in 2024.

WHO Global tuberculosis report 2025

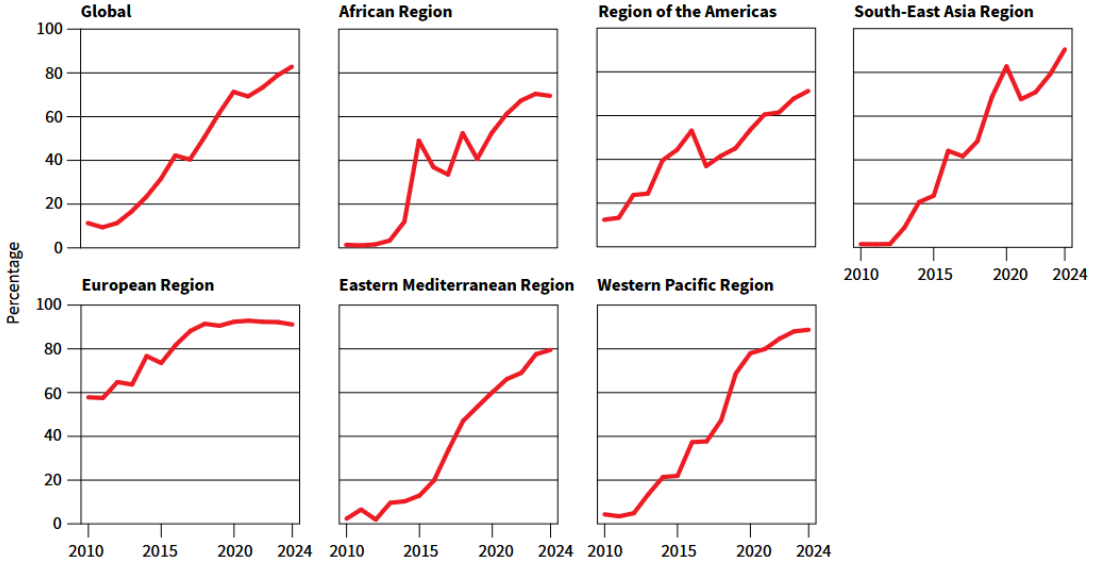
Global number of people diagnosed with MDR/RR-TB (blue) and number enrolled on an MDR-TB treatment regimen (red), compared with estimates of the global number of incident cases of MDR/RR-TB (95% uncertainty interval shown in green), 2015–2024[a]



[a] The time period corresponds to the period for which estimates of the incidence of MDR/RR-TB are available.

Percentage of people diagnosed with bacteriologically confirmed TB who were tested for rifampicin-resistant TB (RR-TB[a]), globally and for WHO regions, 2010–2024

Indonesia is included in the WHO Western Pacific Region for the whole time series.



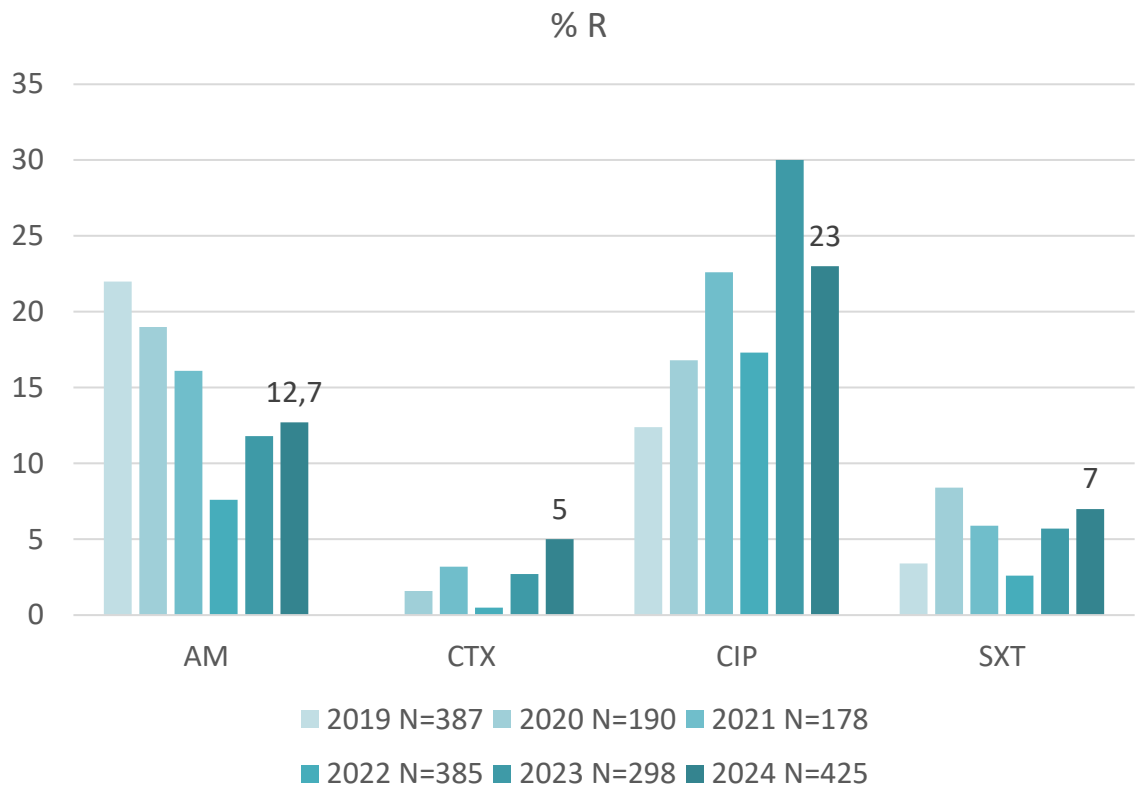
[a] Includes both new and previously treated cases; data for 2017 onwards are for pulmonary cases only.

Salmonella spp.

- Prevladujoči serovari!
- Δ občutljivost predvsem za ciprofloksacin, porast odpornosti proti cefotaksimu.

Table 9 Nontyphoidal *Salmonella*: Resistance to fluoroquinolones[a] (summary of reported or published proportions of resistance, by WHO region)

Data sources based on at least 30 tested isolates	Overall reported range of resistant proportion (%)	Reported range of resistant proportion (%) in blood isolates (no. of reports)
African Region – National data (n=9 countries) – Publications (n=11) from 8 additional countries	 0–35 0–30	 0–30 (n=4)
Region of the Americas – National data (n=13 countries) – Publications (n=1) from 1 additional country	 0–96 0	
Eastern Mediterranean Region – National data (n=4 countries) – Publications (n=4) from 4 additional countries	 2–49 0–46	 6 (n=1)
European Region – National data or report to FWD-Net, (n=29 countries) – Publications (n=1) from1 additional country	 2–3 13	
South-East Asia Region – National data (n=2 countries) – Publication (n=1) from 1 additional country	 0.2–4 1.4	
Western Pacific Region – National data (n=9 countries) – Network/institution data (n=4 from 2 countries) – Publications from remaining countries (n=0)	 0–14 0–0.3	



NIJZ. Epidemiološko spremljanje nalezljivih bolezni v Sloveniji v letu 2019 - 2024

World Health Organization

Figure 3.1. Percentage AMR in bloodstream infections: global and regional estimates, 2023

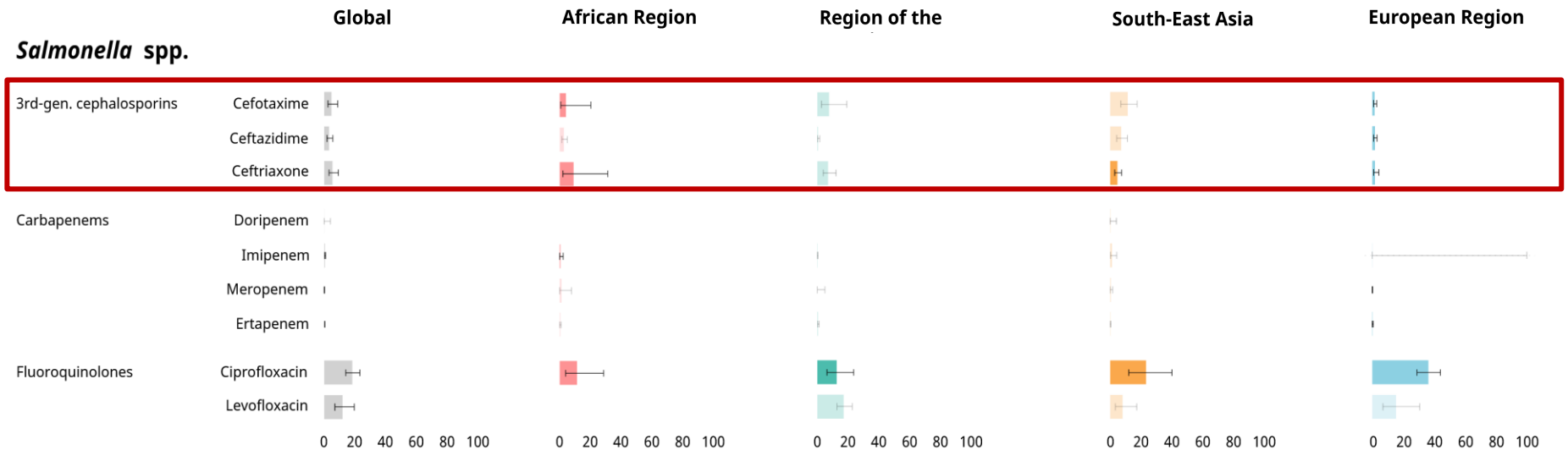
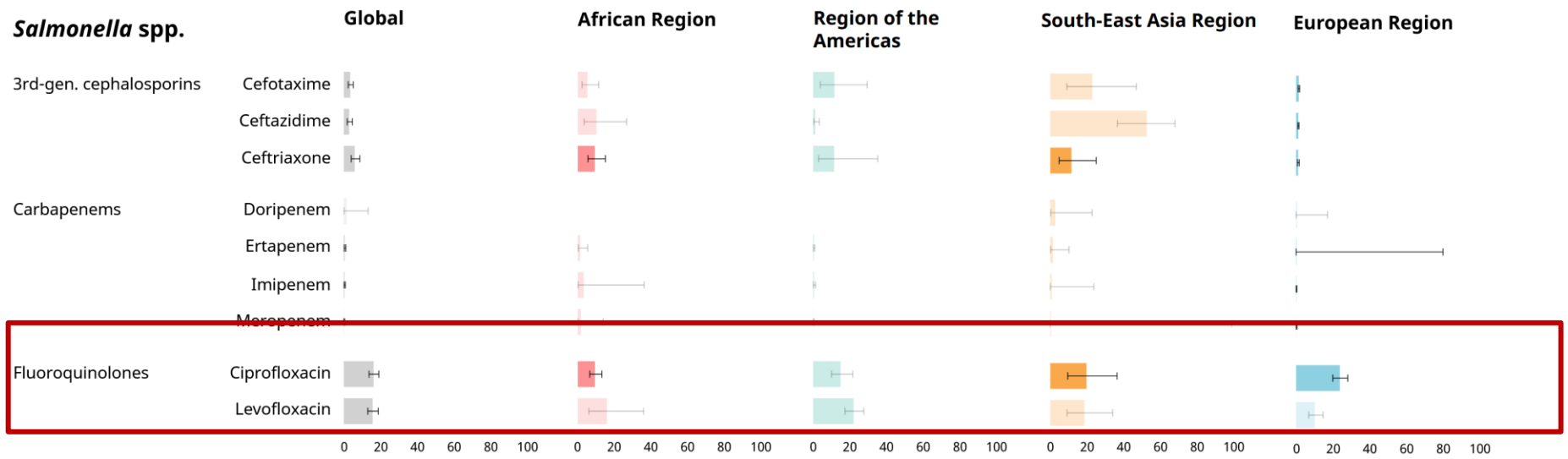


Figure 3.6. Percentage AMR in gastrointestinal infections: global and regional estimates, 2023



The evolution of antimicrobial resistance in *Salmonella* Typhi

Abhilasha Karkey[a], *Guy E. Thwaites*[b,c], *and Stephen Baker*[b,c,d]

Table 1. Reports of resistance to azithromycin and third-generation cephalosporins in organisms causing enteric or typhoid fever

Investigation	Country or location	Year	Reference
Azithromycin resistance			
First report of resistance in *Salmonella enterica* serovar *paratyphi A* leading to treatment failure	Pakistan	2010	[43]
Failure of oral antimicrobials (including azithromycin) in the treatment of a breast abscess caused by *Salmonella enterica* serovar *paratyphi A*	Bangladesh	2012	[54]
Rationale for azithromycin-prescribing practices for enteric fever in India	India	2012	[55]
Azithromycin and ciprofloxacin resistance in *Salmonella* spp. bloodstream infections	Cambodia	2012	[56]
Antimicrobial susceptibility of *Salmonella enterica* serovars in a tertiary care hospital	India	2013	[57]
Failure with azithromycin treatment in a case of *Salmonella enterica* serovar *paratyphi A*	India	2014	[58]
Salmonella subtypes with increased MICs for azithromycin in travellers returning to the Netherlands	Predominantly South Asia	2014	[45]
Third-generation cephalosporin resistance			
blaCTXM-1 ESBL-producing *S.* Typhi from hospitalised patients	Nigeria	2015	[59]
ESBL-producing *Salmonella enterica* serovar Typhi in a traveller returning from Spain	South America	2016	[30]
Individual patient data analysis of 2092 participants enrolled in four randomised controlled trials	Nepal	2017	[60▪]
Occurrence of extended spectrum and AmpC beta lactamases in *Salmonella* spp. isolated from clinical samples	Nigeria	2017	[61]
Azithromycin and third-generation cephalosporin resistance			
Drug-resistance pattern in *S.* Typhi with special reference to cephalosporins and azithromycin in the Gangetic plain	India	2017	[34]

ESBL, extended spectrum beta lactamase.

cephalosporins. Typhoid (enteric) fever caused by *Salmonella* Typhi and *Salmonella* Paratyphi A remains a major public health problem in many parts of Asia and Africa. Currently over a third of isolates in many endemic areas are MDR, and diminished susceptibility or resistance to fluoroquinolones, the drugs of choice for MDR cases over the last decade is an increasing problem. The situation is particularly worrying in resource-limited settings where the few

Campylobacter spp.

- Slaba občutljivost za ciprofloksacin ≈10-20 %
- Dobra občutljivost za eritromicin >98 %
- *C. coli* običajno bolj odporen

- Posamezni večkratno odporni izolati, odporni proti vsem antibiotikom, ki jih je po EUCAST mogoče testirati:

  ciprofloksacin + eritromicin + tetraciklin

  2024: 1/781 *C. jejuni*,

  3/74 *C. coli*

	Campylobacter jejuni		*Campylobacter coli*	
	2024			
Antibiotik	**% R**	**Št. testiranih**	**% R**	**Št. testiranih**
Eritromicin	0,25	781	4	74
Tetraciklin	39	781	43	74
Ciprofloksacin	83	781	81	74

R – odporen

Vir: Poročilo Nacionalnega laboratorija za zdravje, okolje in hrano, 10. 9. 2025.

NIJZ. Epidemiološko spremljanje nalezljivih bolezni v Sloveniji v letu 2024

Shigella spp.

Shigella sonneii – OSR (%R)	2014-2018	2019-2023
N	39	30
AM	48,7	53,3
CRO	10,3	40
CIP	28,2	40
SXT	94,9	76,7

Increase in extensively-drug resistant *Shigella sonnei* infections in men who have sex with men in the EU/EEA and the UK

Table 1. Description of confirmed[1] and possible[1] extensively-drug resistant *Shigella sonnei* cases among MSM by country, EU/EEA countries and the United Kingdom, 2020-2022, as of 17 February 2022

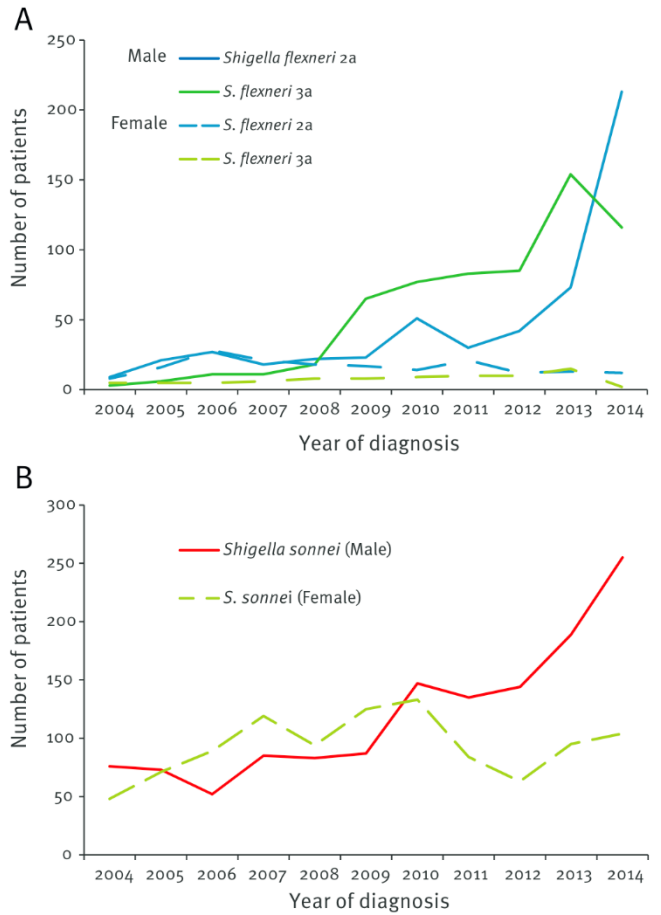
Country	Confirmed cases[1]	Possible cases[1]	Time of sampling or isolation	Genetic relatedness	Demographic data
Austria	9	-	28 June to 16 November 2021	Isolates closely related within cluster and to the representative sequences from the UK (same sequence type by cgMLST; ST152)	Male, age range: 28-41 years
Belgium	4	>30[2]	19 July and 2 September 2021 (confirmed cases); since September 2021 (possible cases)	Isolates closely related within the cluster (0-2 AD) and to two of the representative sequences from the UK (3-5 AD and 4-6 AD)	Male, age range: 0-66 years (confirmed cases)[3]
Denmark	1	-	November 2021	Isolate closely related to representative sequences from the UK (2-3 AD by cgMLST)	Adult male
France	106	-	September 2020 to 15 February 2022	All isolates closely related to representative sequences from the UK (genotype 3.6.1.1.2 (MSM5) [2]	102 males, age range: 13-68 years; four females
Germany	3[4]	-	May to October 2021	Isolates closely related to representative sequences from the UK (2-6 AD)	Two cases are males
Ireland	6	-	Since September 2021	Isolates closely related within cluster and to representative sequence from Norway (within 3 to 7 AD by cgMLST)	-
Italy	3	3	July to September 2021	-	Male, age range: 22-67 years
Norway	6	1	21 September to 16 January 2022	Isolates closely related within cluster (within 3 AD by cgMLST) and to representative sequences from the UK (1 AD); ST152	Male,
Spain	8	22	February 2021 to February 2022	Four isolates sequenced, these are closely related within cluster and to the representative sequences from the UK	Male, age range: 18-56 years
United Kingdom	62	-	4 September 2021 to 26 January 2022	All isolates part of the same 10-SNP cluster by WGS	97% male, median age 34 years

Shigella spp.

***Shigella sonneii* – OSR (%R)**	**2014-2018**	**2019-2023**
N	39	30
AM	48,7	53,3
CRO	10,3	40
CIP	28,2	40
SXT	94,9	76,7

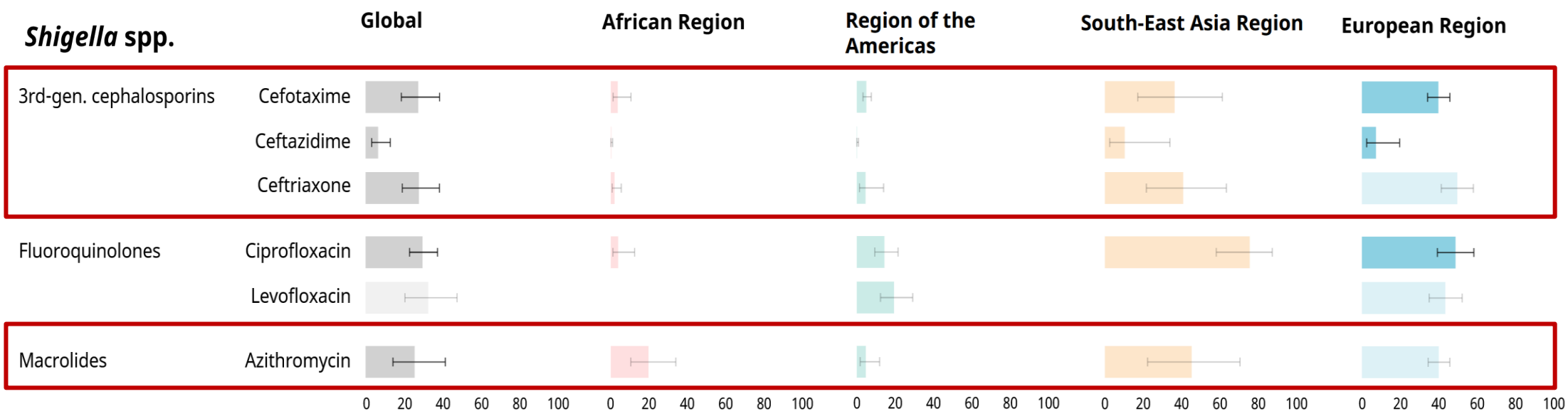
Intensified shigellosis epidemic associated with sexual transmission in men who have sex with men - *Shigella flexneri* and *S. sonnei* in England, 2004 to end of February 2015

I Simms[1], N Field (nigel.field@phe.gov.uk)[1,2], C Jenkins[3], T Childs[1], V L Gilbart[1], T J Dallman[3], P Mook[4], P D Crook[4], G Hughes[1]



World Health Organization

Figure 3.6. Percentage AMR in gastrointestinal infections: global and regional estimates, 2023



Neisseria gonorrhoeae

Tabela 2: Protimikrobna odpornost bakterije *N. gonorrhoeae*, priložnostni vzorec izolatov, Slovenija, 2024

Antibiotik	Število izolatov	Občutljiv		Občutljiv, povečana izpostavljenost		Odporen	
		%	(Število izolatov)	%	(Število izolatov)	%	(Število izolatov)
Cefiksim	148	100	(148)	/	(/)	0	(0)
Ceftriakson	148	100	(148)	/	(/)	0	(0)
Azitromicin*	147	83,7*	(123)	/	(/)	16,3*	(24)
Ciprofloksacin	148	21,6	(32)	0,7	(1)	77,7	(115)
Betalaktamaza je bila testirana pri 148 izolatih, pozitivna je bila pri 12,8 % (n=19) izolatov.							

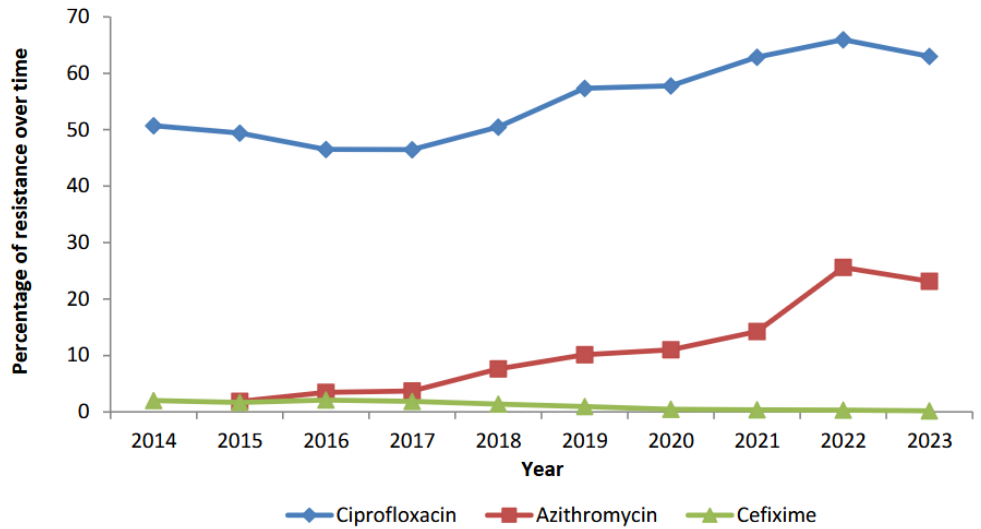
Vir: Poročilo laboratorijev o protimikrobni odpornosti bakterije N. gonorrhoeae, 2025.

** Mejne vrednosti pri azitromicinu so izračunane glede na epidemiološko mejno vrednost (v angl.: epidemiological cut-off value – ECOFF), določeno s strani EUCAST-a, ki razlikuje divje seve od izolatov z zmanjšano občutljivostjo pri vrednosti minimalne inhibitorne koncentracije (MIK) ≤ 1 mg/L.*

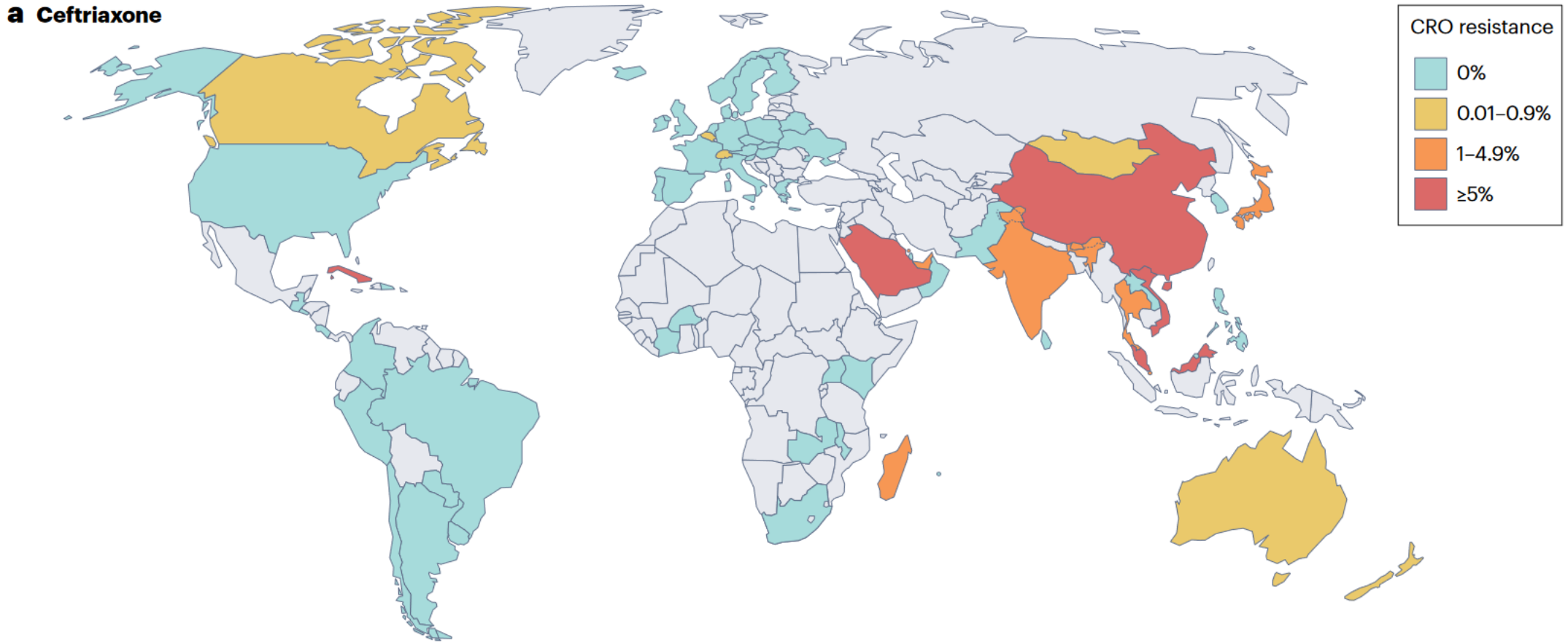
Table 11 *Neisseria gonorrhoeae*: decreased

Data sources based on at least 30 tested isolates	Overall reported range of proportion with decreased susceptibility (%)
African Region – National data and/or GASP data (n=2 countries) – Publications (n=5) from 5 additional countries	0–12 0
Region of the Americas – National data and/or GASP/ GISP data (n=4 countries) – Publications from remaining countries (n=0)	0–31
Eastern Mediterranean Region – National data and/or GASP data (n=2 countries) – Publications (n=1) from 1 additional country	0–12 0
European Region – National data and/or EURO-GASP/GRASP data (n=17) – Publications (n=3) from 3 additional countries	0–36 0
South-East Asia Region – National data and/or GASP data (n=5 countries) – Publications from remaining countries (n=0)	0–5
Western Pacific Region – National data and/or GASP data (n=12 countries) – Publications from remaining countries (n=0)	0–31

Figure 1. Percentage of resistant *Neisseria gonorrhoeae* by antimicrobial and year, Euro-GASP, 2014–2023



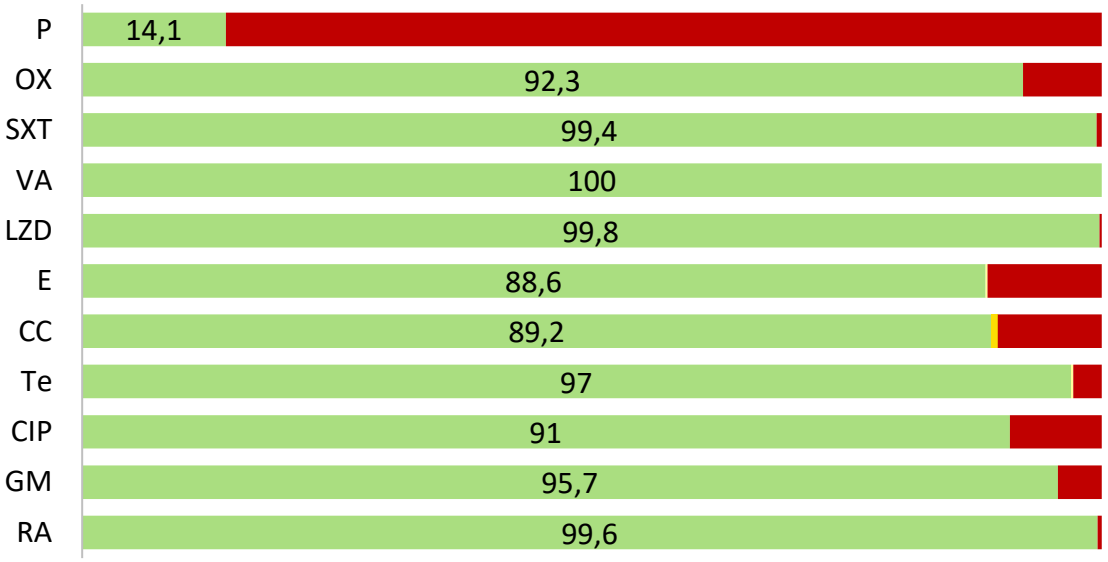
Neisseria gonorrhoeae



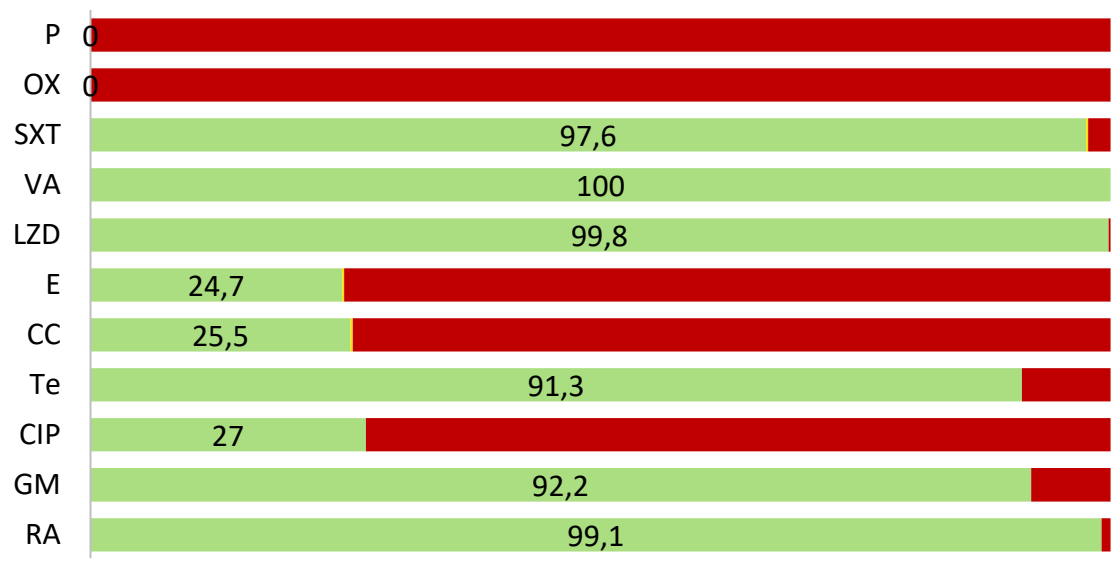
Jensen in Unemo. Nat Rev Microbiol 2024

Staphylococcus aureus

S.aureus



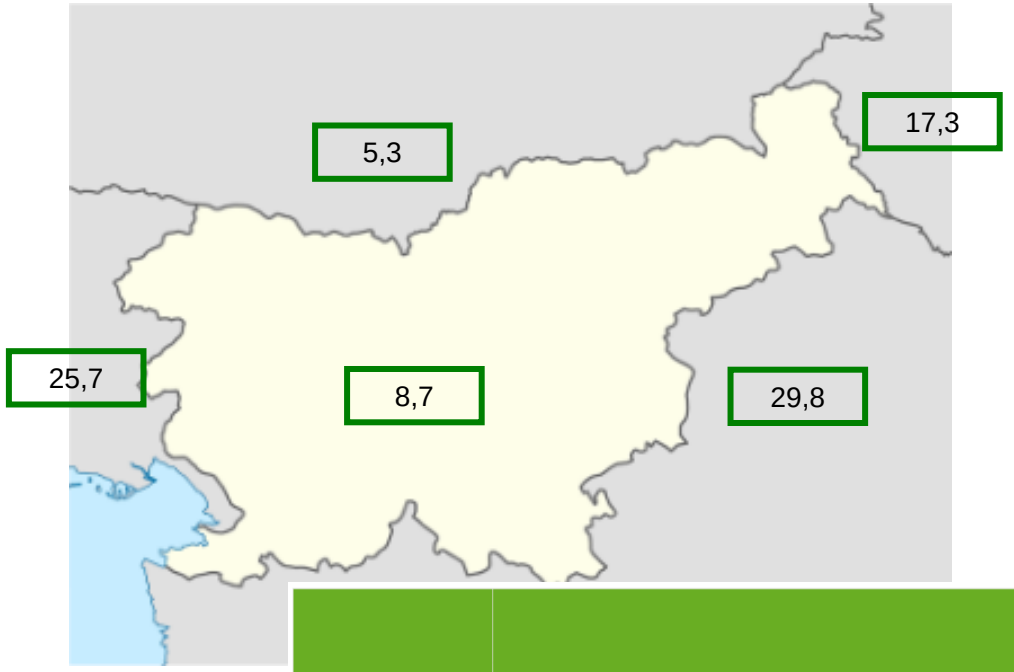
MRSA



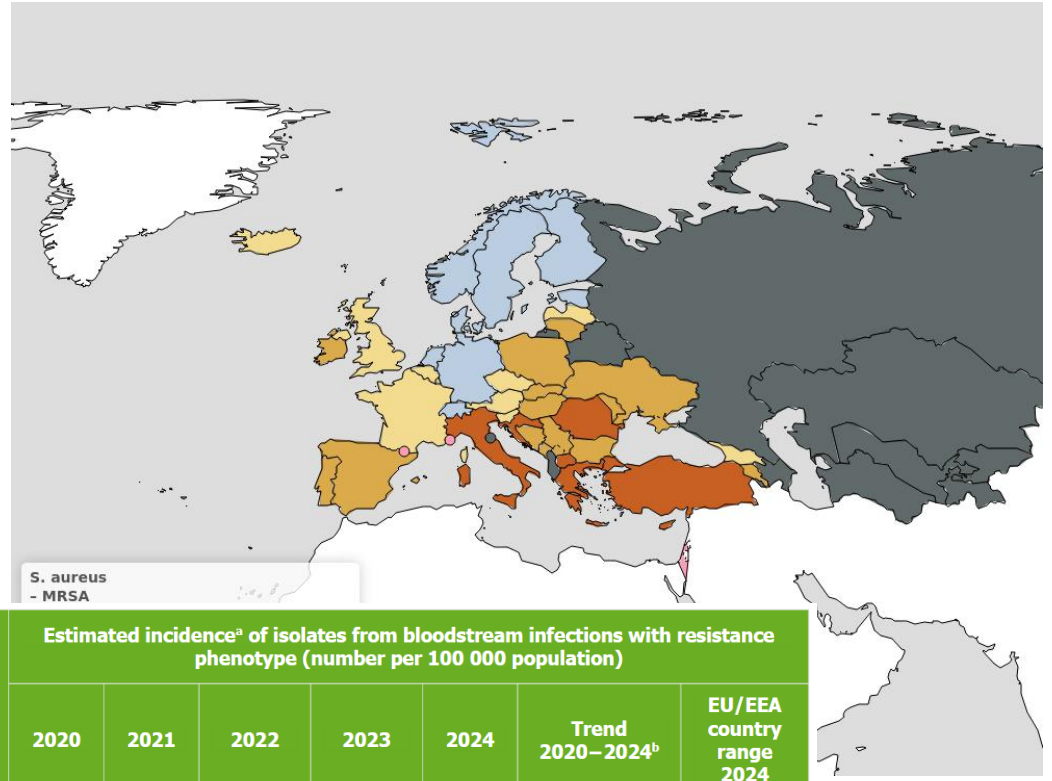
Vir: SKOUPZ

Stapylococcus aureus - MRSA

Local data - EARS-Net 2024

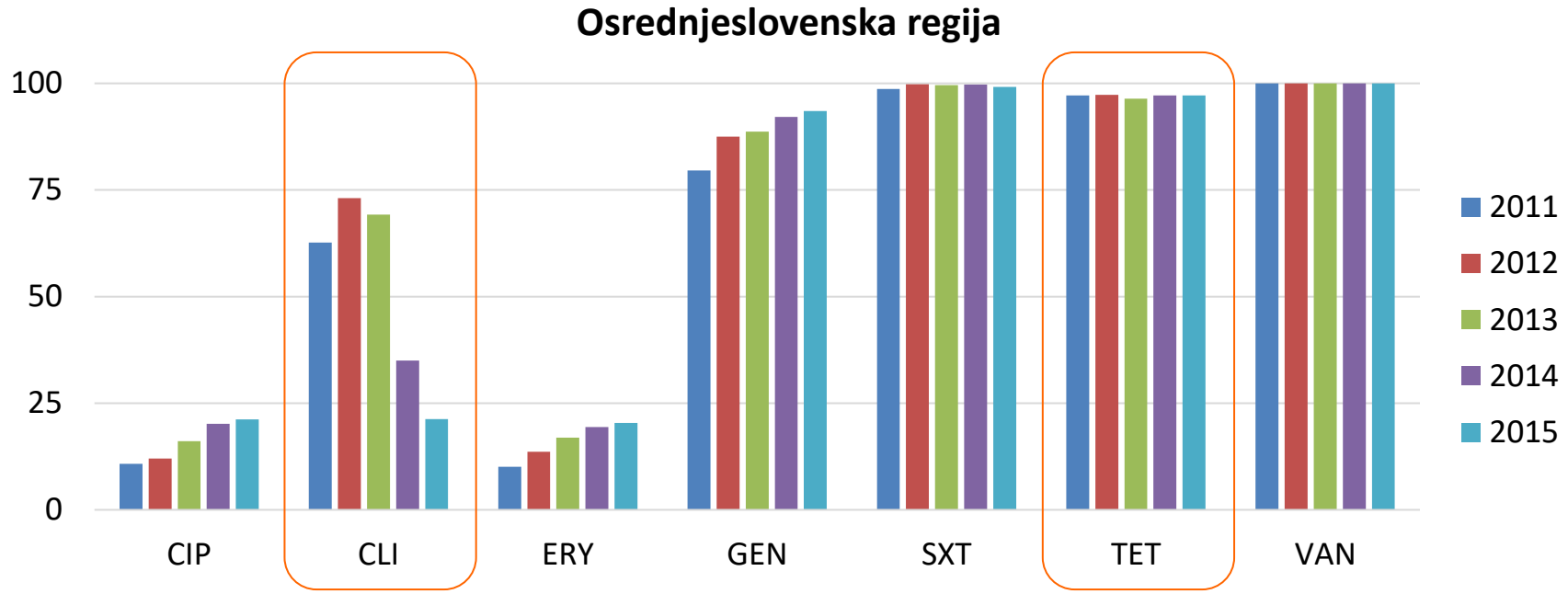


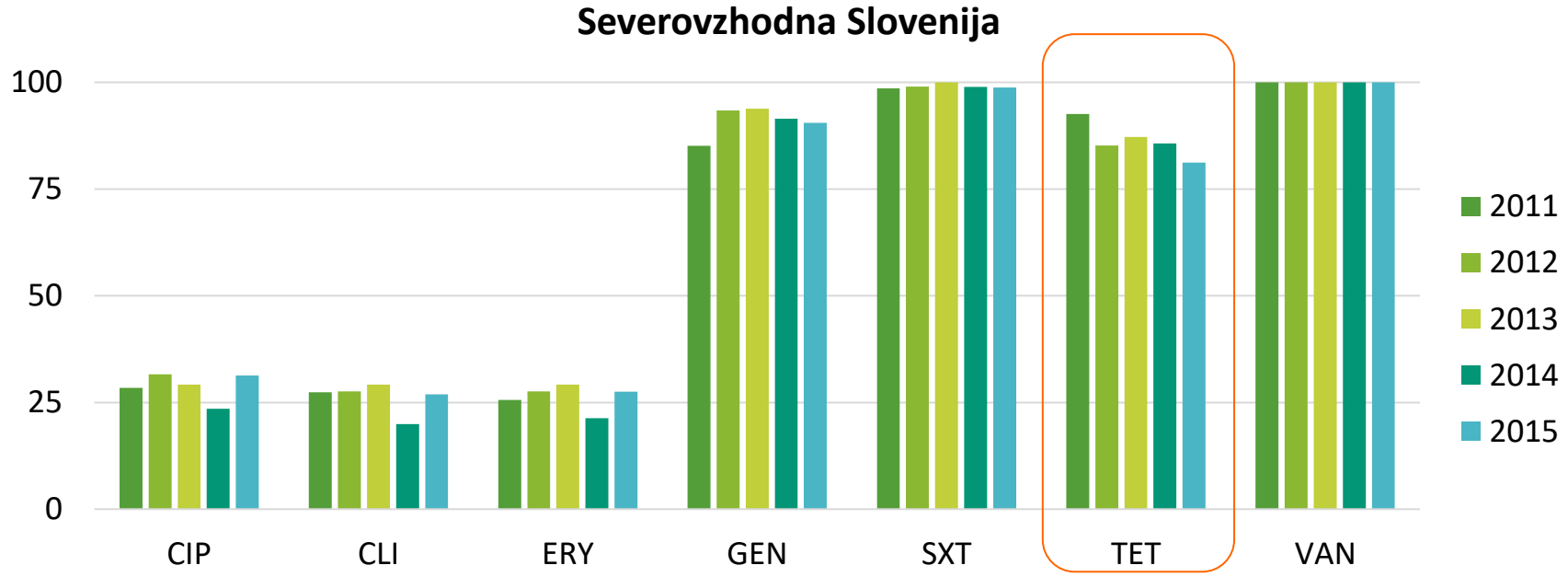
ECDC EARS-Net / WHO CAESAR 2024



Bacterial species	Antimicrobial group/agent	Estimated incidence[a] of isolates from bloodstream infections with resistance phenotype (number per 100 000 population)						
		2020	2021	2022	2023	2024	Trend 2020–2024[b]	EU/EEA country range 2024
Staphylococcus aureus	MRSA[c]	4.68	4.21	4.39	4.32	4.43	-	0.55–13.63

S. aureus - MRSA

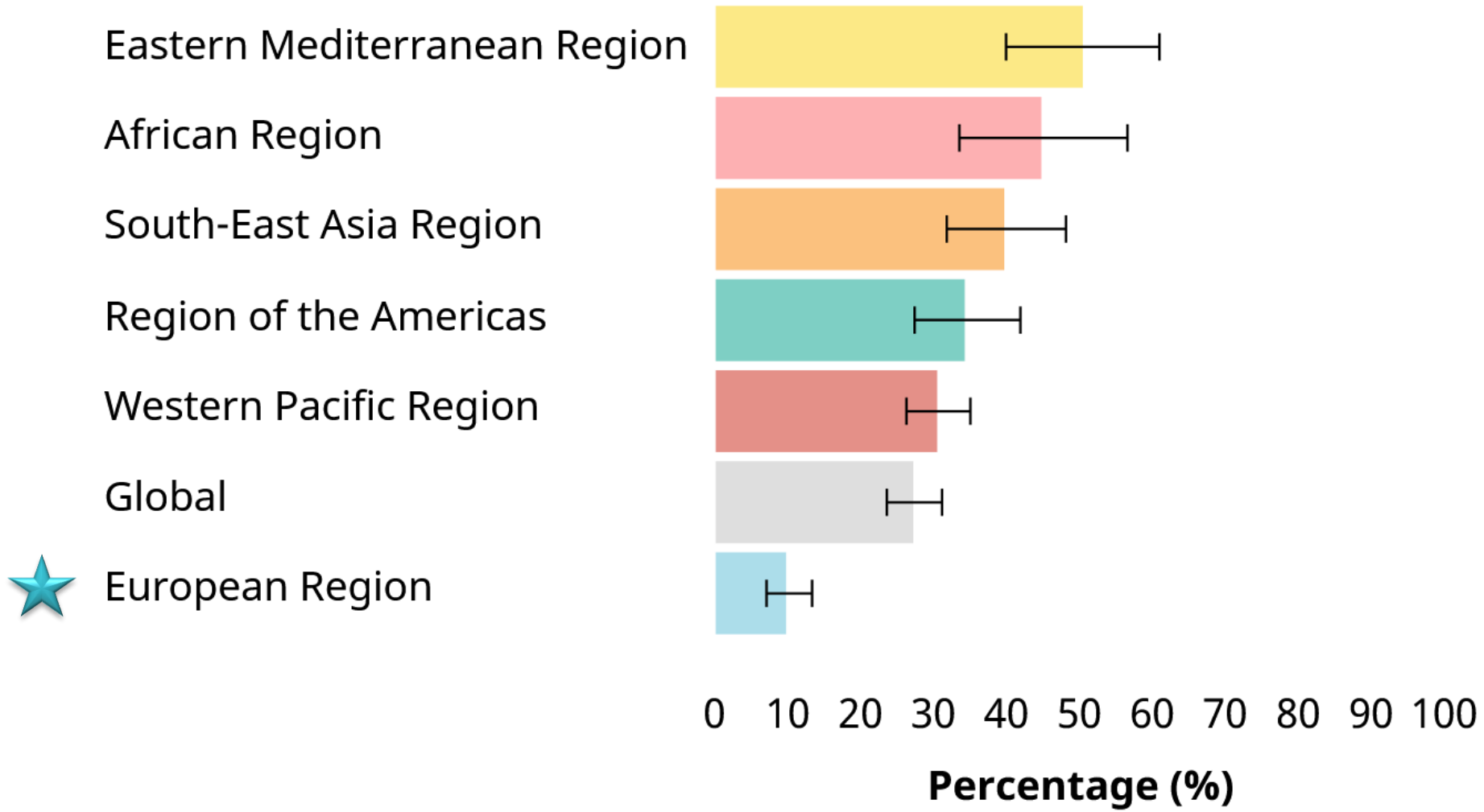




V celotni Sloveniji opažamo nižanje deleža proti tetraciklinu občutljivih MRSA, kar nakazuje na vdor LA-MRSA

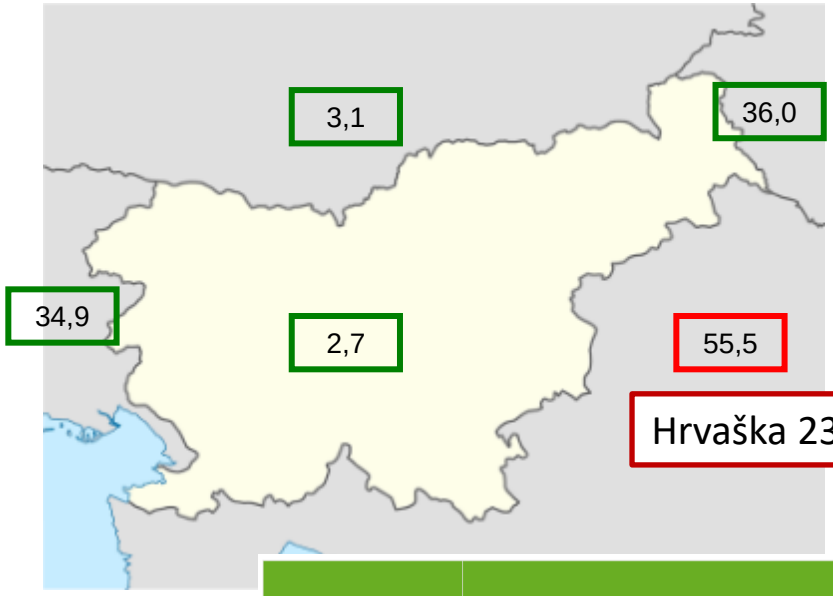
World Health Organization

S. aureus - Methicillin resistance



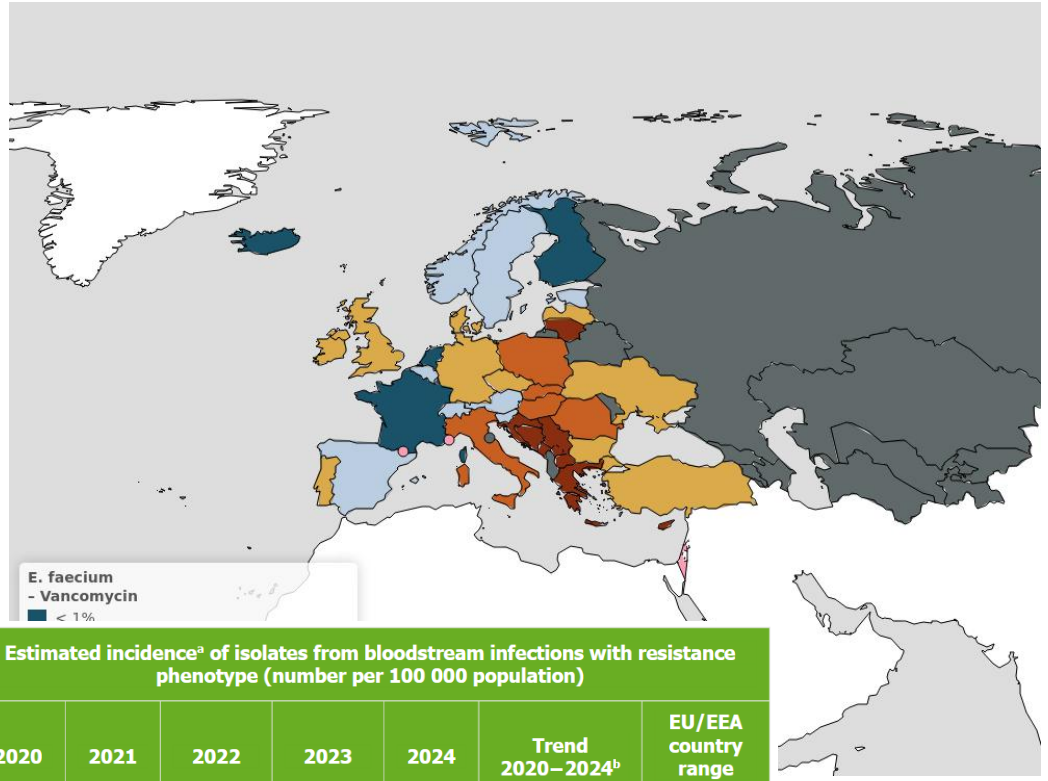
Enterococcus faecium - VRE

Lokalni podatki - EARS-Net 2024



Hrvaška 23,5 → 55,5 %

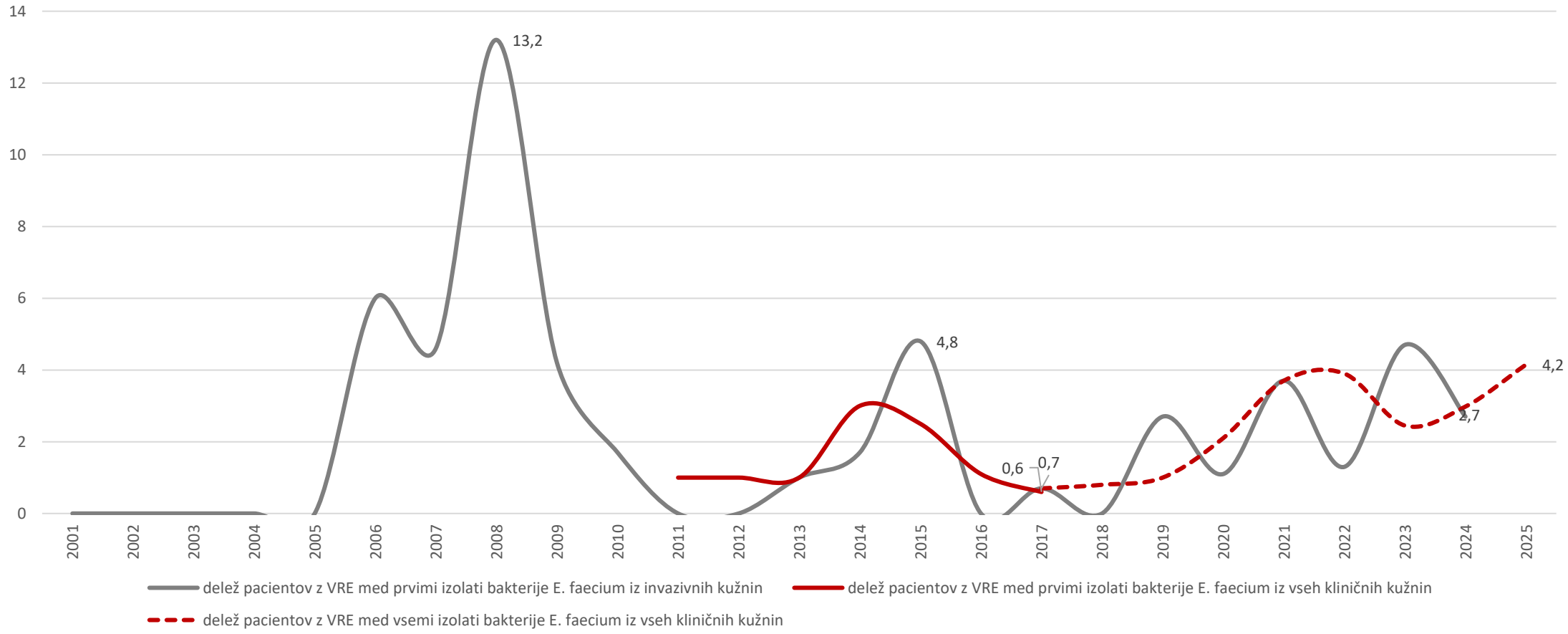
ECDC EARS-Net / WHO CAESAR 2024



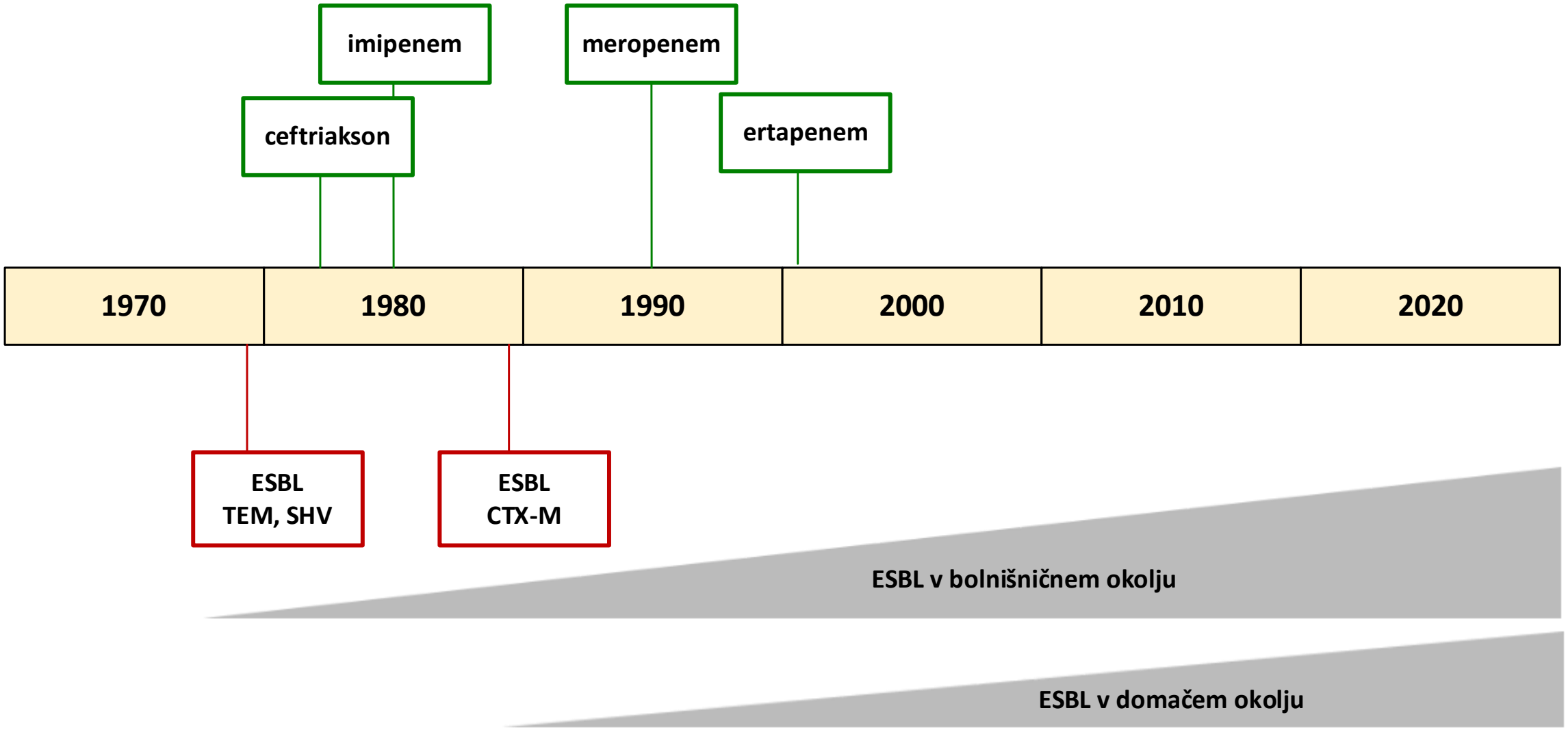
Bacterial species	Antimicrobial group/agent	Estimated incidence[a] of isolates from bloodstream infections with resistance phenotype (number per 100 000 population)						
		2020	2021	2022	2023	2024	Trend 2020–2024[b]	EU/EEA country range 2024
Enterococcus faecium	Vancomycin resistance	1.76	2.15	2.06	1.93	1.96	-	0.00–9.97

EARS-Net/CAESAR

E. faecium - VRE

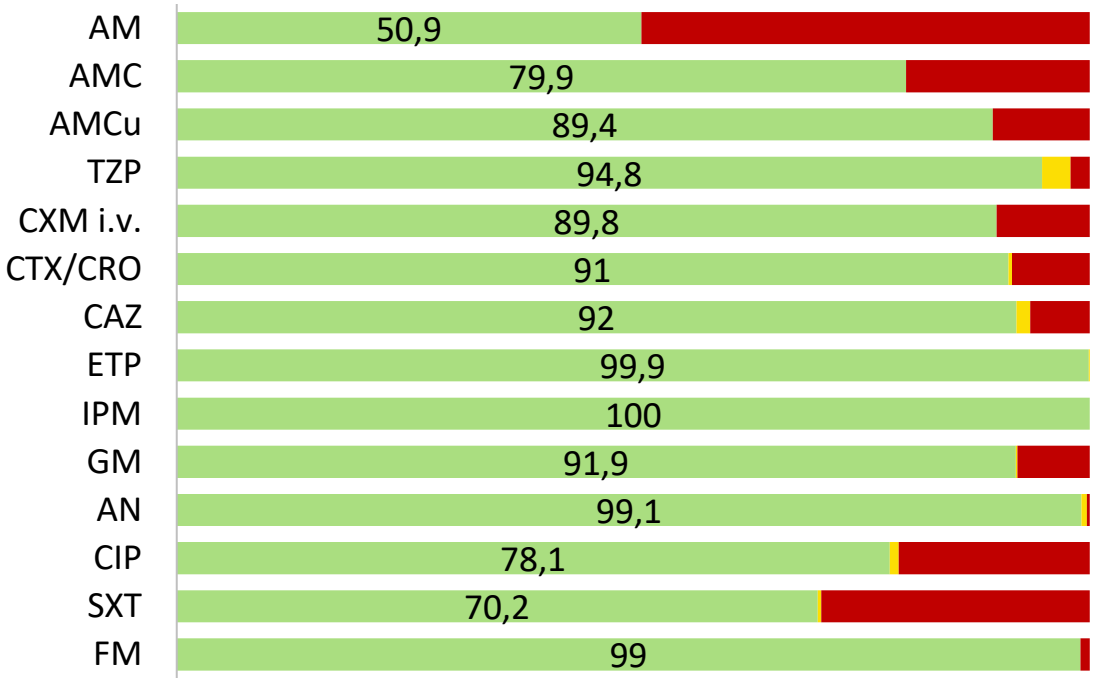


Gramnegativne bakterije

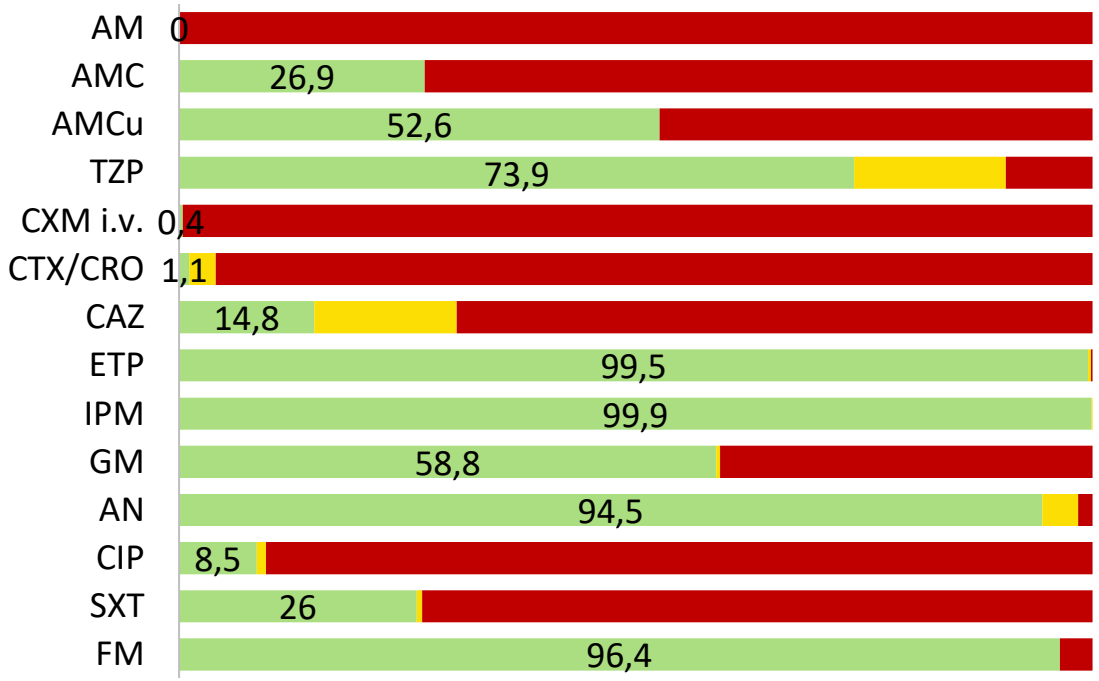


Escherichia coli

E.coli



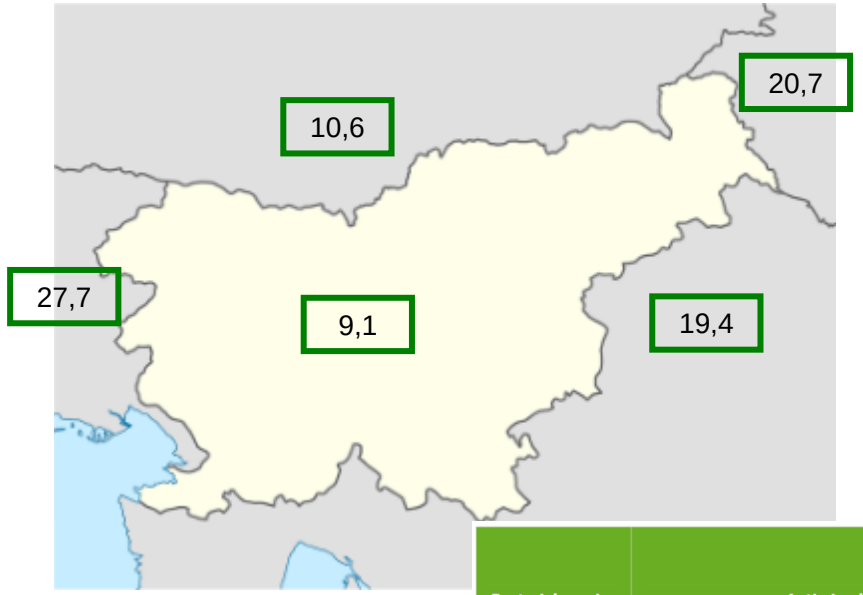
E.coli - ESBL



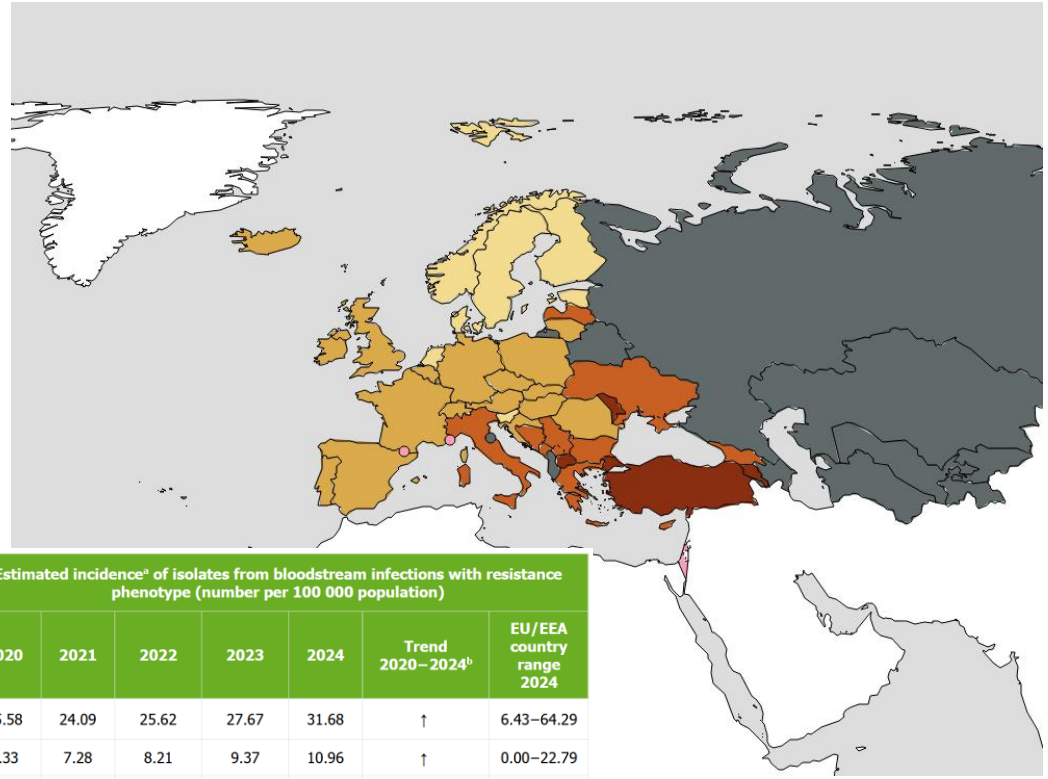
Vir: SKOUPZ

Escherichia coli – Cef3G R

Local data - EARS-Net 2024

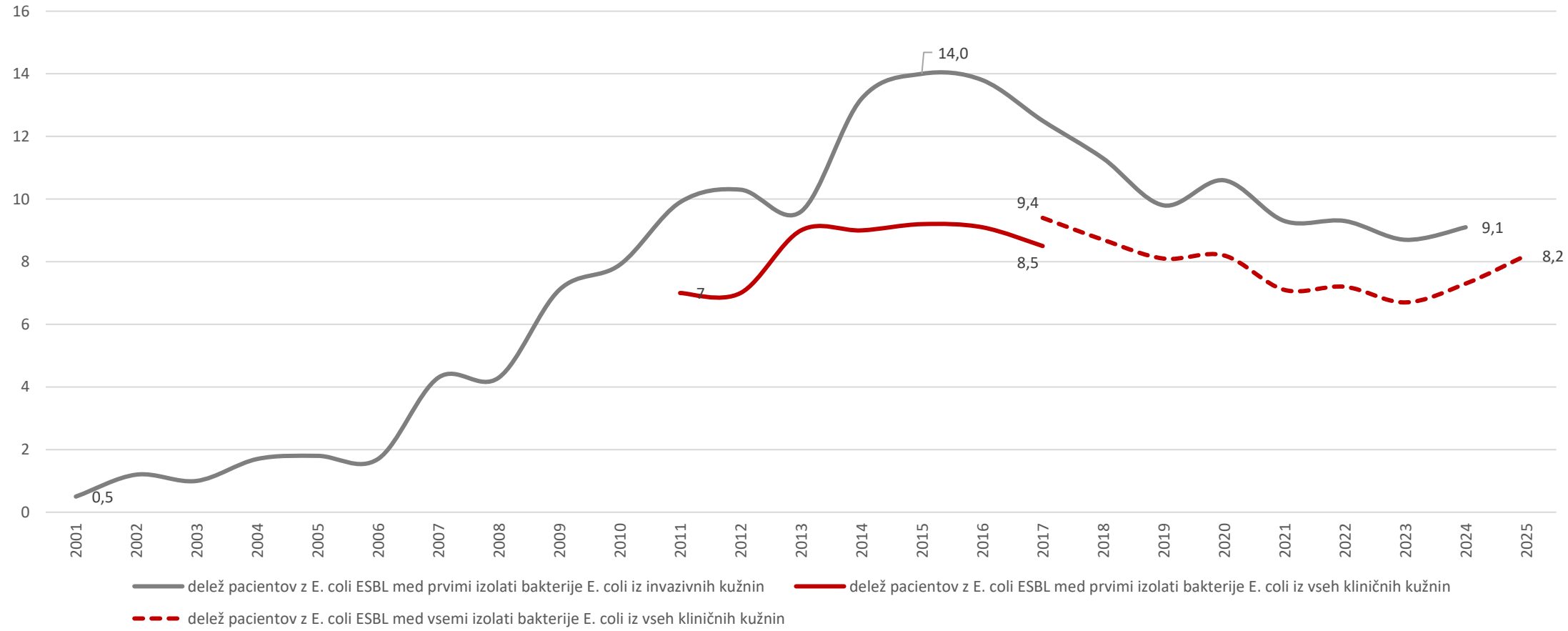


ECDC EARS-Net / WHO CAESAR 2024



Bacterial species	Antimicrobial group/agent	Estimated incidence[a] of isolates from bloodstream infections with resistance phenotype (number per 100 000 population)						
		2020	2021	2022	2023	2024	Trend 2020–2024[b]	EU/EEA country range 2024
Escherichia coli	Aminopenicillin (amoxicillin/ampicillin) resistance	25.58	24.09	25.62	27.67	31.68	↑	6.43–64.29
	Third-generation cephalosporin (cefotaxime/ceftriaxone/ceftazidime) resistance	8.33	7.28	8.21	9.37	10.96	↑	0.00–22.79
	Carbapenem (imipenem/meropenem) resistance	0.08	0.07	0.11	0.13	0.15	↑	0.00–1.26
	Fluoroquinolone (ciprofloxacin/levofloxacin/ofloxacin) resistance	13.48	11.78	12.73	14.17	15.71	↑	3.07–39.61
	Aminoglycoside (gentamicin/tobramycin) resistance	5.76	4.80	5.23	5.99	6.68	-	0.00–27.28
	Combined resistance to third-generation cephalosporins, fluoroquinolones, and aminoglycosides	2.78	2.33	2.58	2.99	3.31	↑	0.00–19.99

E. coli - ESBL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delež pacientov z E. coli ESBL med prvimi izolati bakterije E. coli iz vseh kliničnih kužnin
delež pacientov z E. coli ESBL med vsemi izolati bakterije E. coli iz vseh kliničnih kužnin

World Health Organization

Figure 3.8. Percentage AMR in urinary tract infections: global and regional estimates, 2023

Escherichia coli - ESBL

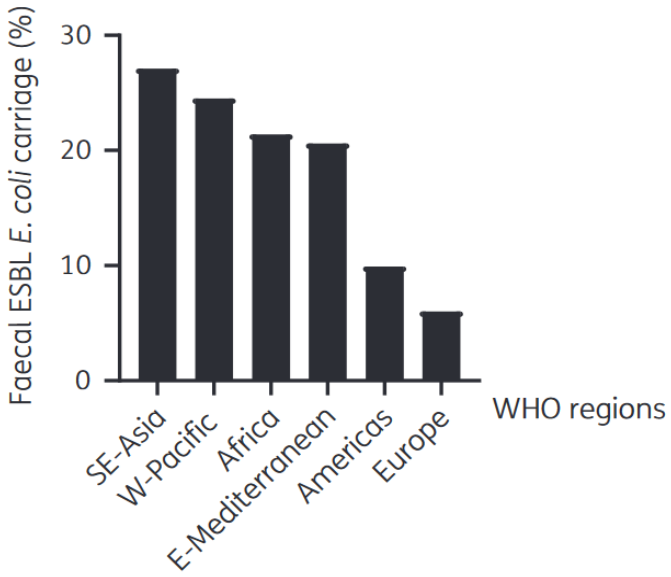


Figure 2. Pooled prevalence of intestinal ESBL *E. coli* carriage among healthy individuals in six WHO regions.[30] E-Mediterranean, Eastern Mediterranean; SE-Asia, South-East Asia; W-Pacific, Western Pacific region.

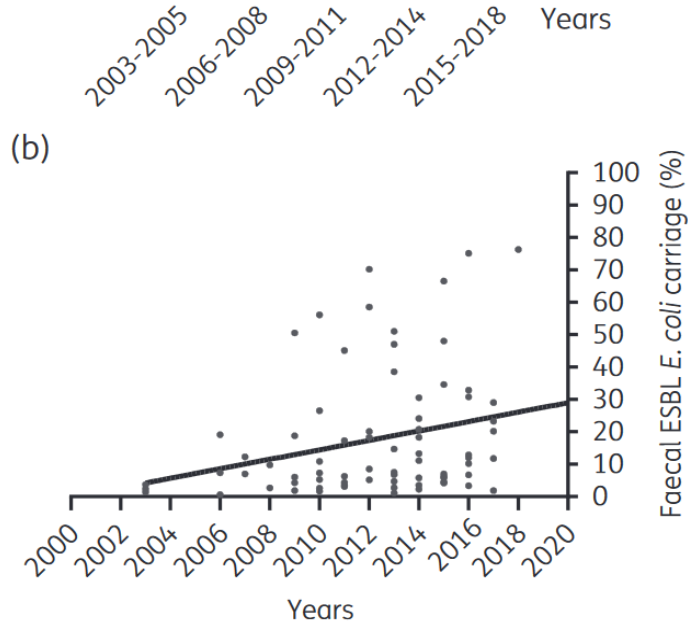


Figure 3. Global trend in faecal ESBL *E. coli* carriage among healthy individuals. (a) Pooled prevalence showing a clear increase from one 3 year interval to another. (b) A simple linear regression plot depicting the trend of carriage (1.5% rise per year, $P = 0.021$).

z *E. coli* – ESBL je kolonizirana vsaj šestina svetovne populacije

Bezabih, JAC 2022

CMR
Journals.ASM.org

Trends in Human Fecal Carriage of Extended-Spectrum β-Lactamases in the Community: Toward the Globalization of CTX-M

October 2013

Paul-Louis Woerther,[a] Charles Burdet,[b,c] Elisabeth Chachaty,[a] Antoine Andremont[b]

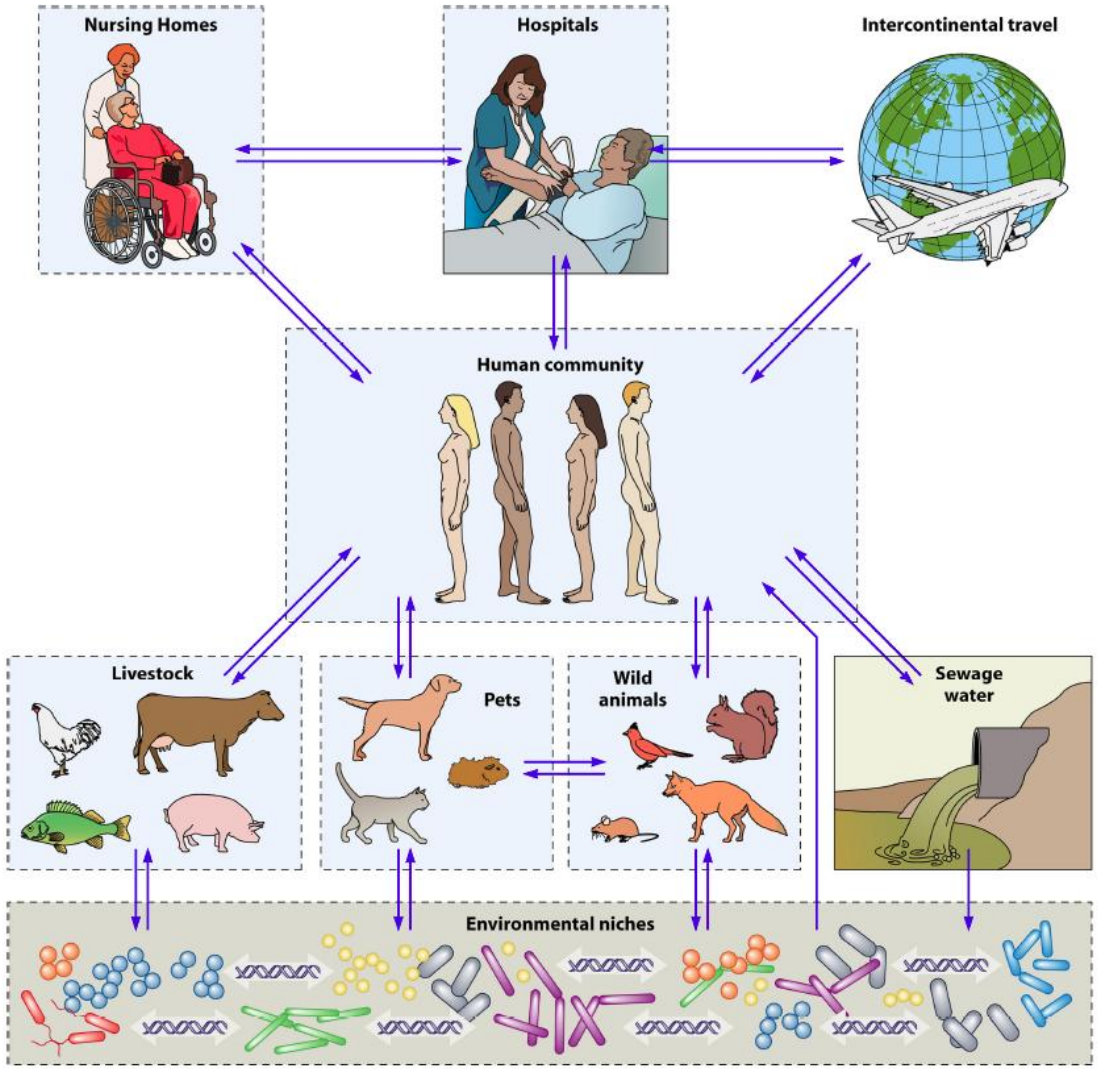


FIG 3 Representation of the main digestive or environmental reservoirs of ESBL-E to which the worldwide human community belongs and is also exposed. Each independent reservoir is included in a dashed black outline, inside which cross-transmission may occur. Arrows show the flux of ESBL-E from one reservoir to another. Environmental niches comprise mainly water, soils, and plants, where genetic material exchanges between bacteria of digestive and/or environmental origin occur.

Znotraj gospodinjstva:

- **Pacient prenese ESBL na 67 % članov gospodinjstva.**
- **Navadno nosilstvo članov ni dolgotrajno.**

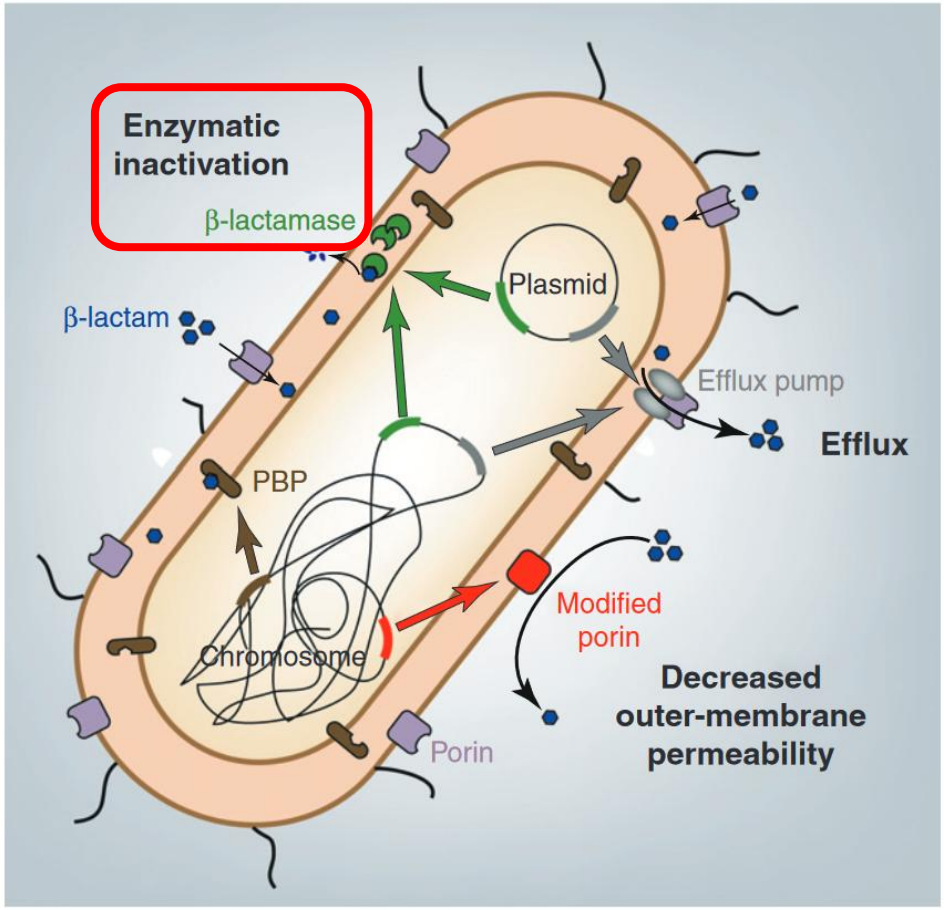
Haverkate MR, et al., Quantifying within-household transmission of extended-spectrum b -lactamase-producing bacteria, CMI 2016

Odpornost proti karbapenemom

Dokument SKUOPZ 003.

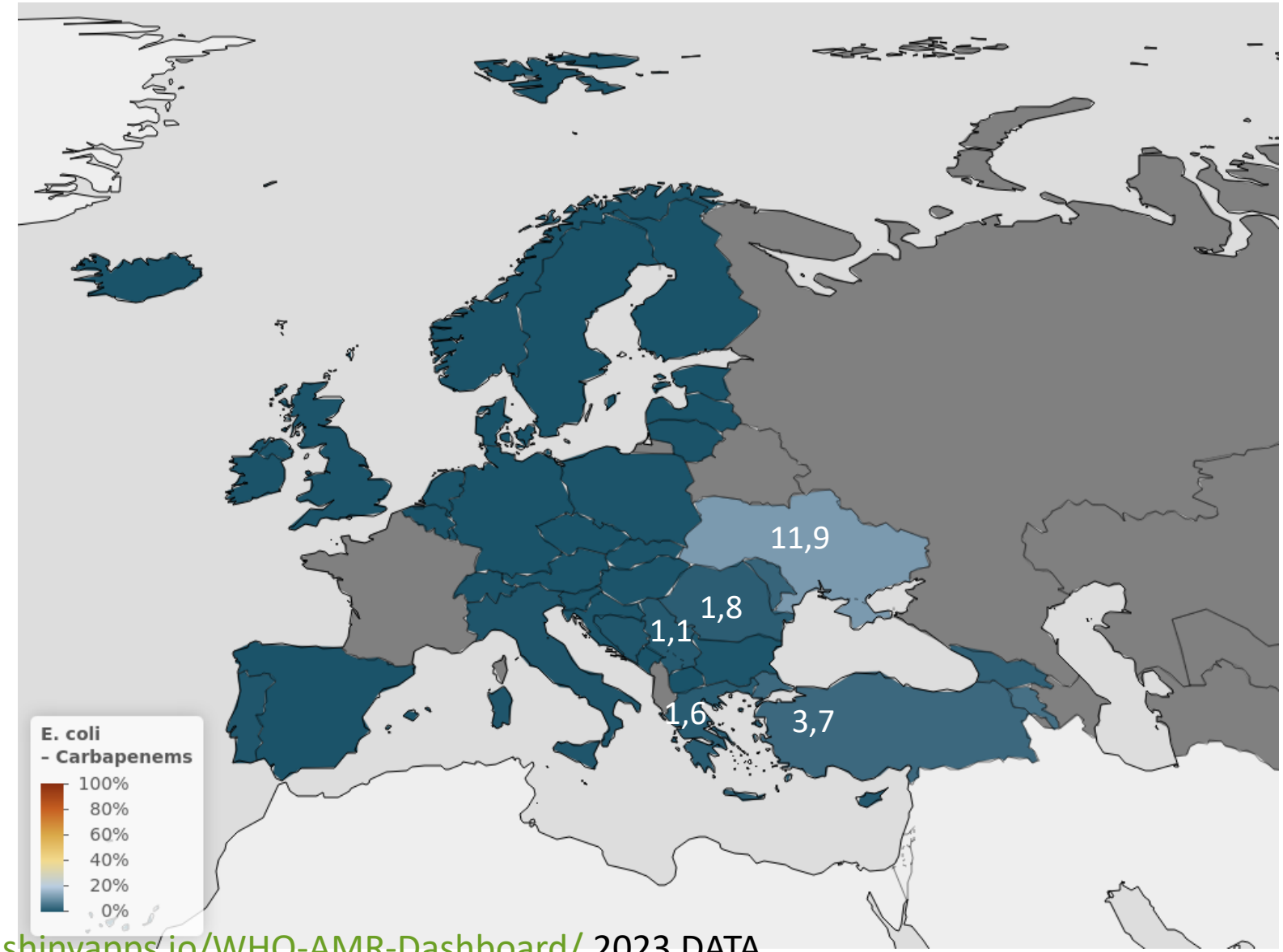
Enterobakterije, *Acinetobacter baumannii* in *Pseudomonas aeruginosa* - označevanje večkratno odpornih izolatov in okrajšave preiskav nadzornih kužnin - 2. izdaja, april 2022.

- Enterobakterije:
  - CRE
  - CRE-CPE / CPE
- *Pseudomonas aeruginosa*
  - CRPS
  - CRPs-CP
- *Acinetobacter* spp.
  - CRAb/CRAb-CP



Nordmann 2012

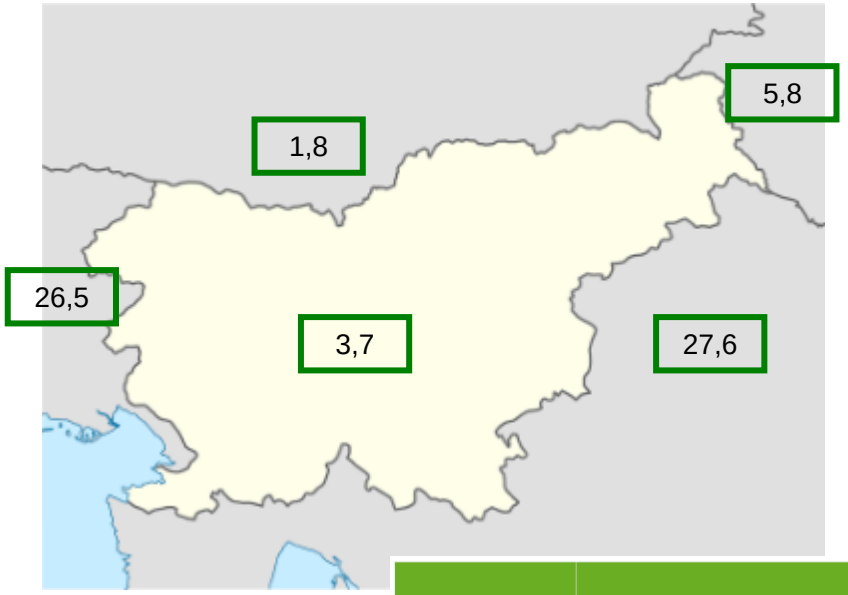
Escherichia coli - CRE



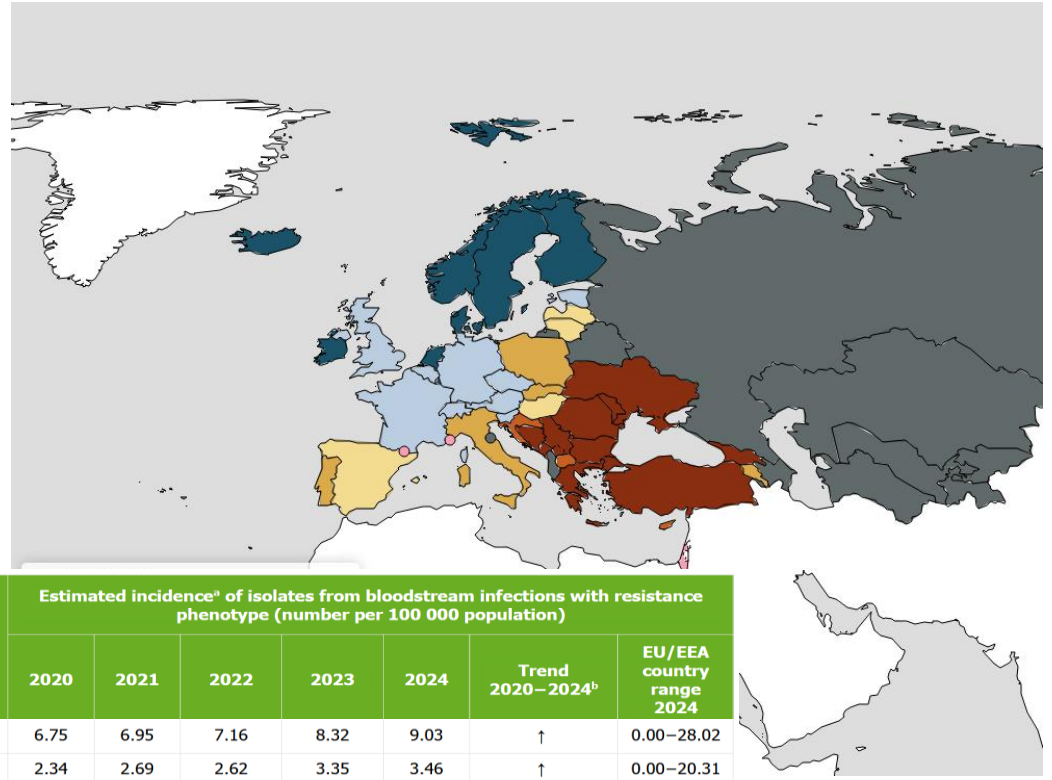
https://worldhealthorg.shinyapps.io/WHO-AMR-Dashboard/ 2023 DATA

Klebsiella pneumoniae - CRE

Lokalni podatki - EARS-Net 2024

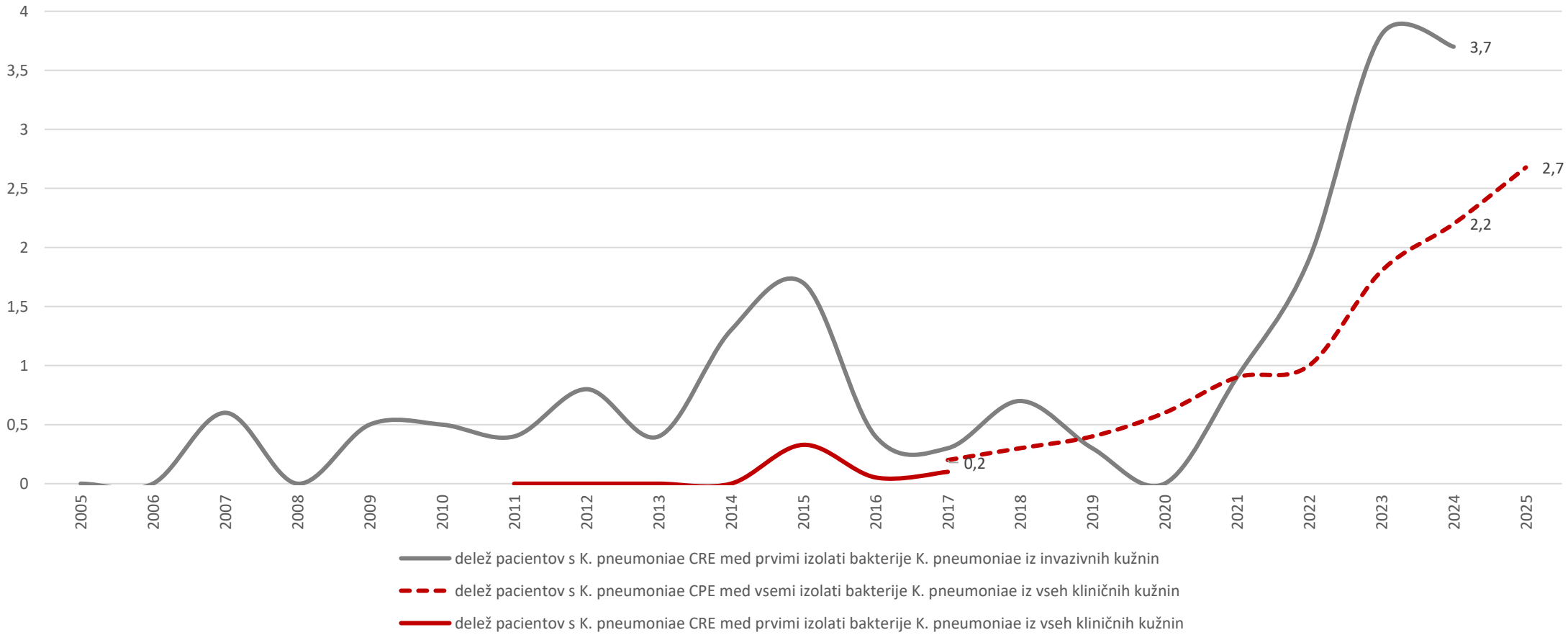


ECDC EARS-Net / WHO CAESAR 2024



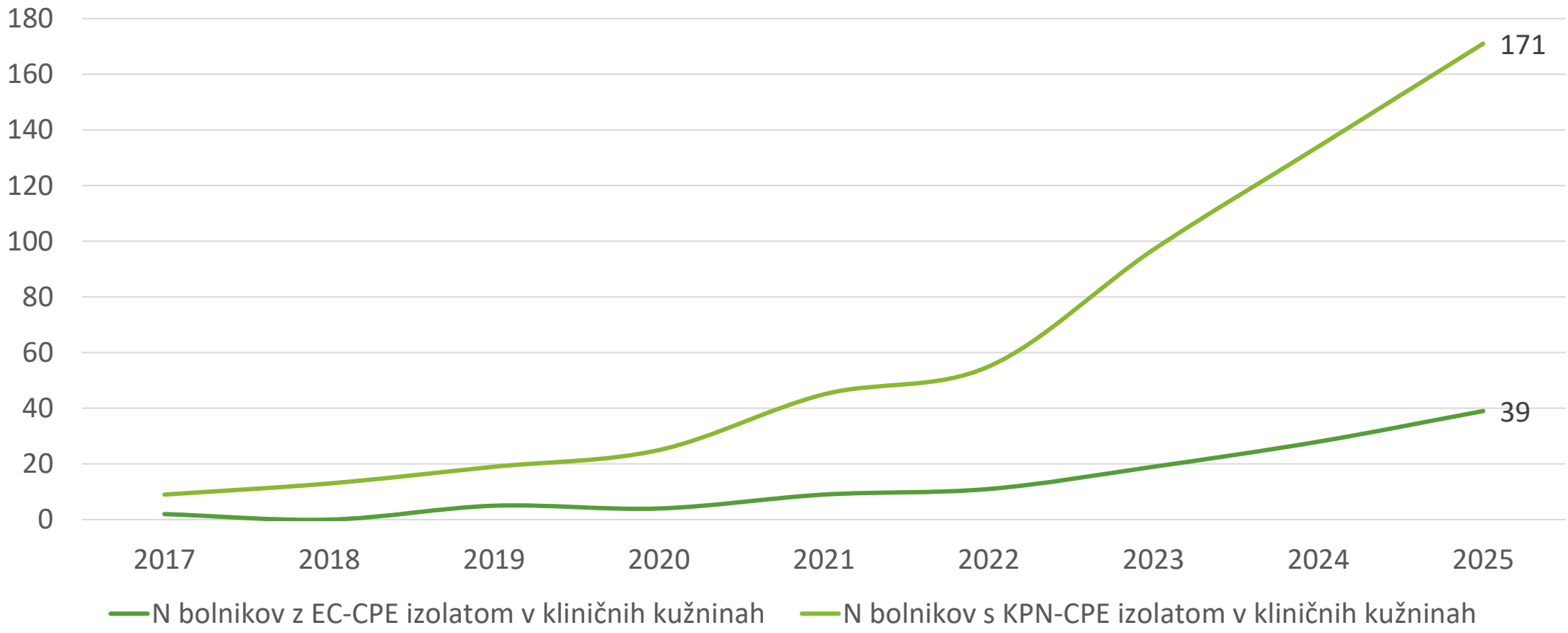
Bacterial species	Antimicrobial group/agent	Estimated incidence[a] of isolates from bloodstream infections with resistance phenotype (number per 100 000 population)						
		2020	2021	2022	2023	2024	Trend 2020–2024[b]	EU/EEA country range 2024
Klebsiella pneumoniae	Third-generation cephalosporin (cefotaxime/ceftriaxone/ceftazidime) resistance	6.75	6.95	7.16	8.32	9.03	↑	0.00–28.02
	Carbapenem (imipenem/meropenem) resistance	2.34	2.69	2.62	3.35	3.46	↑	0.00–20.31
	Fluoroquinolone (ciprofloxacin/levofloxacin/ofloxacin) resistance	6.74	6.77	6.90	7.93	8.53	↑	0.00–28.77
	Aminoglycoside (gentamicin/tobramycin) resistance	4.36	4.53	4.60	5.33	5.58	↑	0.00–18.81
	Combined resistance to third-generation cephalosporins, fluoroquinolones, and aminoglycosides	3.83	4.03	4.05	4.67	4.84	↑	0.00–17.52

K. pneumoniae – CRE-CPE/CPE

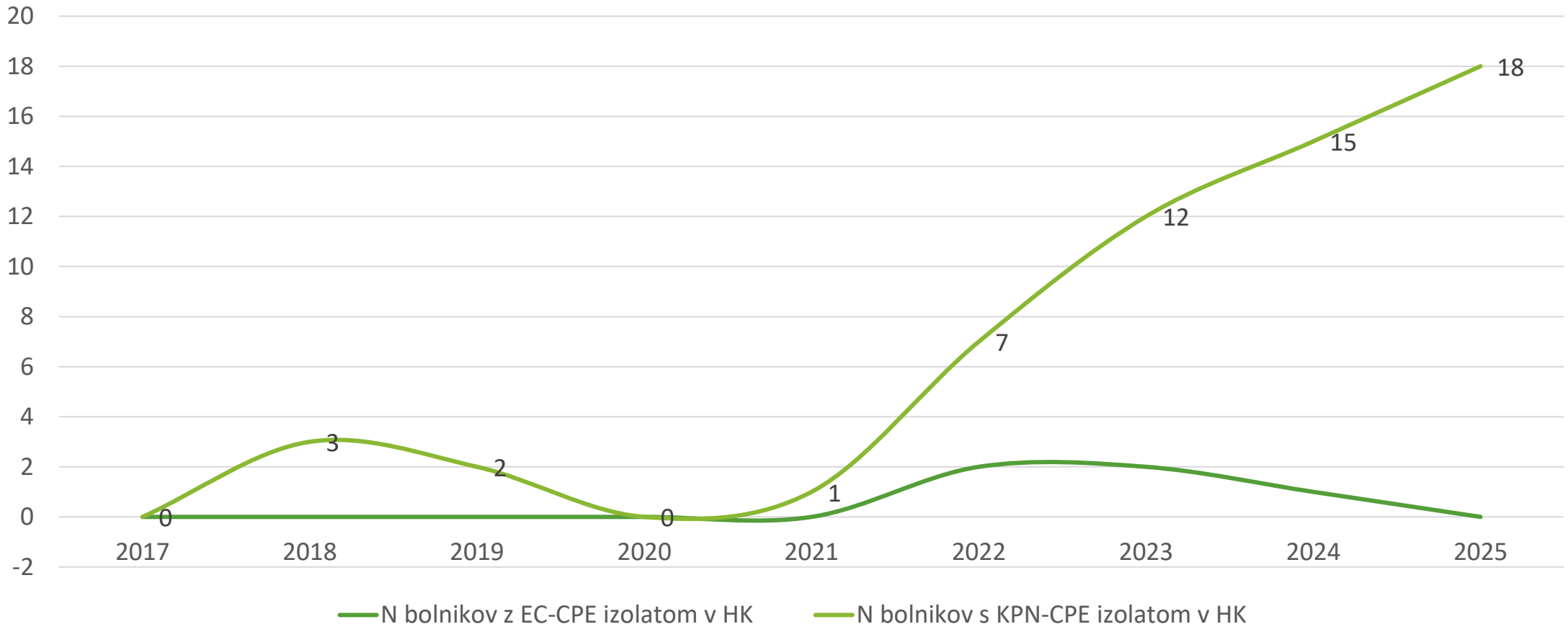


Izolati s serinskimi karbapenemazami (OXA-48, KPC): 38,9 %
izolati z **metalokarbapenemazami** (NDM/VIM +/OXA-48): **60,9 %**

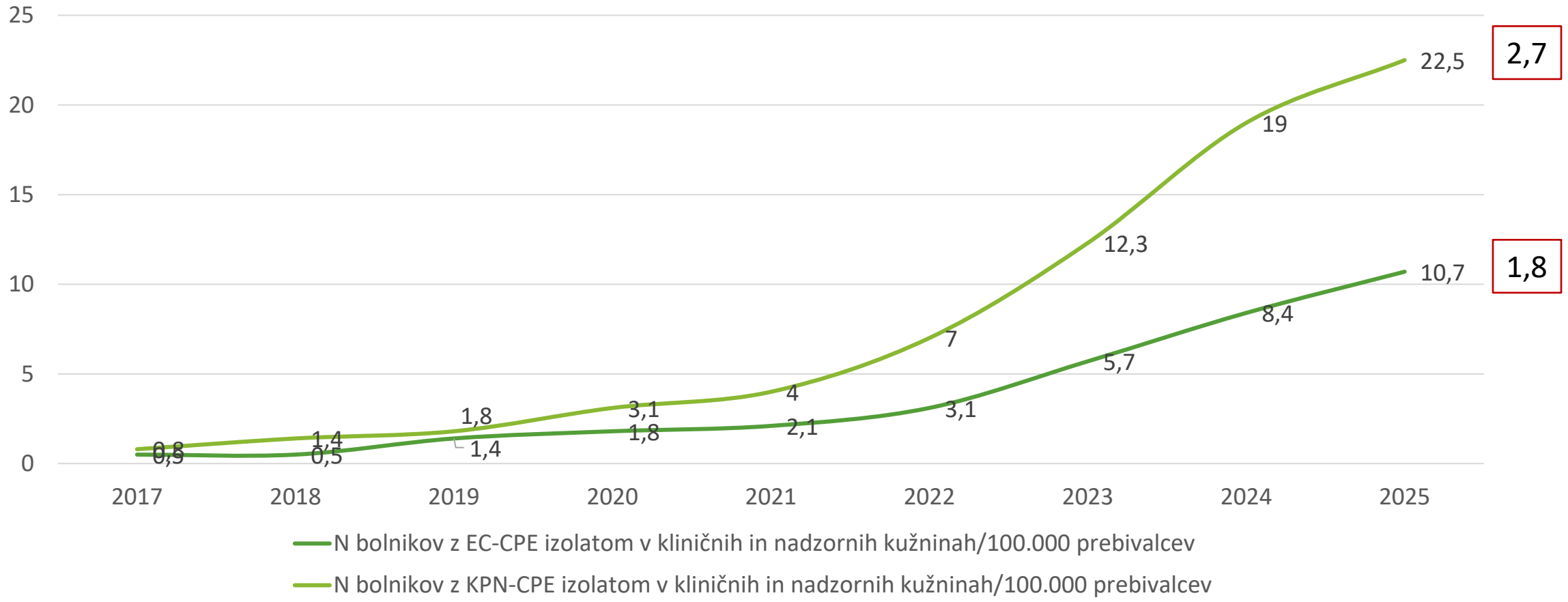
CPE v kliničnih kužninah



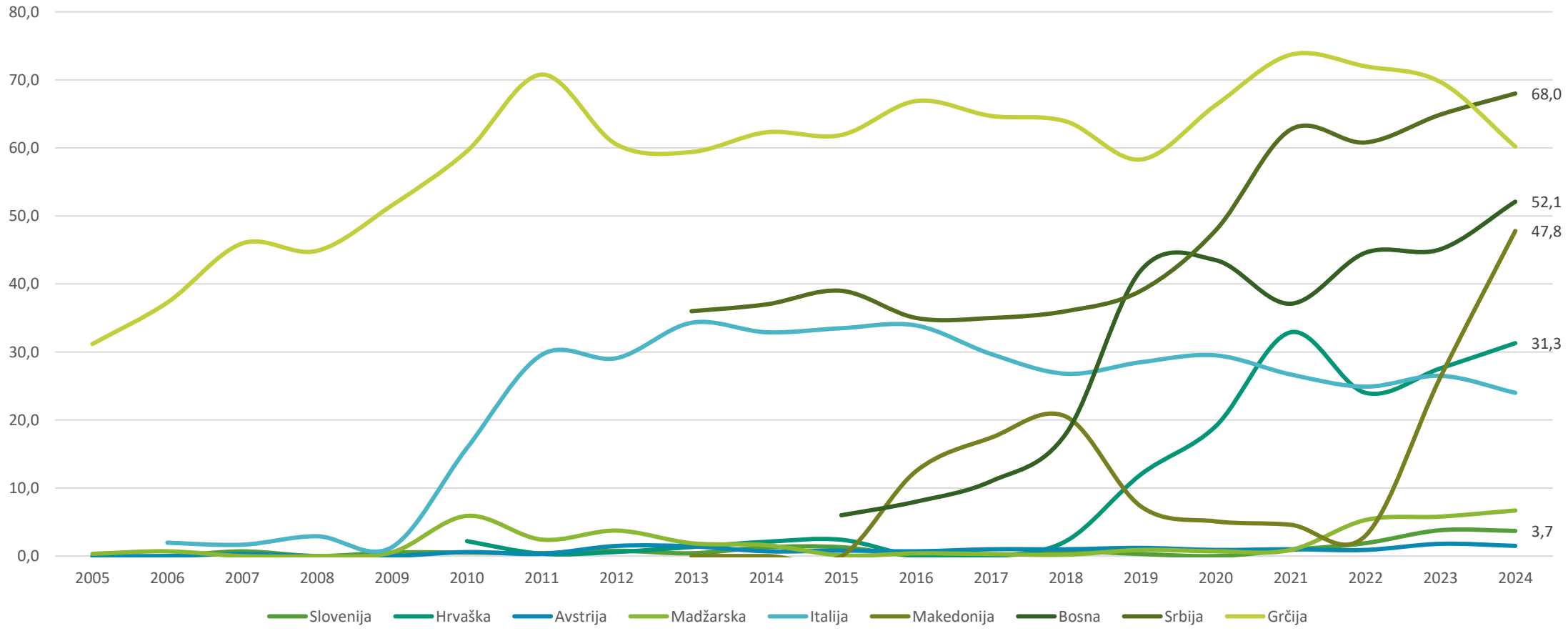
CPE v hemokulturah



CPE klinične in nadzorne kužnine



EUROVISION SONG CONTEST



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Household transmission of carbapenemase-producing Enterobacteriaceae: a prospective cohort study

J Antimicrob Chemother 2021; **76**: 1299–1302
doi:10.1093/jac/dkaa561 Advance Access publication 8 January 2021

Objectives: To estimate the transmission rate of carbapenemase-producing Enterobacteriaceae (CPE) in households with recently hospitalized CPE carriers.

Methods: We conducted a prospective case-ascertained cohort study. We identified the presence of CPE in stool samples from index subjects, household contacts and companion animals and environmental samples at regular intervals. Linked transmissions were identified by WGS. A Markov model was constructed to estimate the household transmission potential of CPE.

Results: Ten recently hospitalized index patients and 14 household contacts were included. There were seven households with one contact, two households with two contacts, and one household with three contacts. Index patients were colonized with $bla_{\text{OXA-48-like}}$ ($n=4$), $bla_{\text{KPC-2}}$ ($n=3$), bla_{IMP} ($n=2$), and $bla_{\text{NDM-1}}$ ($n=1$), distributed among divergent species of Enterobacteriaceae. After a cumulative follow-up time of 9.0 years, three family members (21.4%, 3/14) acquired four different types of CPE in the community (hazard rate of 0.22/year). The probability of CPE transmission from an index patient to a household contact was 10% (95% CI 4%–26%).

Conclusions: We observed limited transmission of CPE from an index patient to household contacts. Larger studies are needed to understand the factors associated with household transmission of CPE and identify preventive strategies.

Household transmission of NDM-producing *E. coli* in New Zealand

Matthew R Blakiston, Helen Heffernan, Sally A Roberts, Joshua T Freeman

ABSTRACT

This report describes the introduction of an extensively antibiotic-resistant carbapenemase-producing *Escherichia coli* into a hospital in Auckland, New Zealand, by a patient who was a household contact of recent travellers to the Indian subcontinent. The carbapenemase was identified as New Delhi metallo-β-lactamase (NDM) and reflects probable household transmission in the context of a recent upsurge in NDM-producing *Enterobacteriaceae* isolation in New Zealand. The observations in this report suggest that hospital screening practices to identify carbapenemase-producing *Enterobacteriaceae* (CPE) colonised patients may need to be extended to include travellers to high-risk countries who were not hospitalised during their trip, and possibly also their close contacts.

Risk factors for acquisition of multidrug-resistant Enterobacterales among international travellers: a synthesis of cumulative evidence

Results: A total of 20 studies (5253 travellers from high-income countries) were included in the meta-analysis. South Asia [58.7%; 95% confidence interval (CI), 44.5–72.5%] and Northern Africa (43.9%; 95% CI 37.6–50.3%) were the travel destinations with the highest proportion of MRE acquisition. Inflammatory bowel disease (OR 2.1; 95% CI 1.2–3.8), use of antibiotics (OR 2.4; 95% CI 1.9–3.0), traveller's diarrhoea (OR 1.7; 95% CI 1.3–2.3) and contact with the healthcare system overseas (OR 1.5; 95% CI 1.1–2.2) were associated with MRE colonization. Vegetarians (OR 1.4; 95% CI 1.0–2.0) and backpackers (OR 1.5; 95% CI 1.2–1.8) were also at increased odds of MRE colonization. Few studies ($n = 6$) investigated preventive measures and found that consuming only bottled water/beverages, meticulous hand hygiene and probiotics had no protective effect on MRE colonization.

Conclusions: International travel is an important driver for MRE spread worldwide. Future research needs to identify effective interventions to reduce the risk of MRE acquisition as well as design strategies to reduce local transmission on return.

Carbapenemase-producing Enterobacterales and vancomycin-resistant *Enterococcus faecium* carriage in patients who have traveled in foreign countries: A single center 5-year prospective study

Methods: From 2014 to 2018, patients who had travelled abroad in the previous year before their admission underwent microbiological screening and were pre-emptively isolated. Contact precautions were verified and CPE/VRE cross-transmission events investigated.

Results: Among 1,780 screened patients, 59 (3.3%) were colonized with CPE and/or VRE, of whom 17 (29.3%) (Table 1). Among the 17 carriers not hospitalized abroad, 16 carried only CPE and one only VRE. Among the patients hospitalized abroad, 11.5% were carriers versus 1.5% of the patients not hospitalized abroad ($P < 10^{-6}$).

68 letni moški, TX ledvice

K. pneumoniae OXA-48/NDM

Vzorec: **Kri - gojišče BACTEC - II. Periferna vena** (Odvzeto 18.07.2023 ob 13:30)

V direktnem preparatu iz pozitivne hemokulture, obarvanem po Gramu, smo videli po Gramu negativne bacile.

Aerobna hemokultura

Rezultat 1. ***Klebsiella pneumoniae*** - CRE-CPE
Izolirani sev izloča karbapenemazo. Posvetujte se z infektologom ali kliničnim mikrobiologom. Potrebna je dosledna izolacija bolnika.

Anaerobna hemokultura: **NEGATIVNO**. Preiskava je zaključena.

Za pravilno interpretacijo rezultatov antibiograma je potrebno upoštevati komentarje pod tabelo in poznati osnovne opredelitve EUCAST.

	1.
ampicilin	R
amoksicilin+klavulanska kislina	R
piperacilin+tazobaktam	R
cefuroksim (parenteralni)	R
cefotaksim	R
ceftriakson	R
ceftazidim	R
cefepim	R
cefiderocol	R
ceftolozan+tazobaktam	R >32/4
ceftazidim+avibaktam	R >16/4
ertapenem	R >2
meropenem	R >16
imipenem	R >16
imipenem+relebaktam	R 32/4
aztreonam	R >32
gentamicin	R
amikacin	R
ciprofloksacin	R
levofloksacin	R
trimetoprim+sulfametoksazol	R
tigeciklin	NI 1
kolistin	(S) 0,5
fosfomicin (parenteralni)	R 64

1 letna deklica, anomalija sečil

K. pneumoniae NDM

Vzorec: **Kultura bakterij iz urina; vzorec v gojišču** (Odvzeto 20.07.2023 ob 08:00)

Preiskava na aerobne bakterije

Rezultat 1. ***Klebsiella pneumoniae*** - CRE-CPE
Izolirani sev izloča karbapenemazo. Posvetujte se z infektologom ali kliničnim mikrobiologom. Potrebna je dosledna izolacija bolnika.

Za pravilno interpretacijo rezultatov antibiograma je potrebno upoštevati komentarje pod tabelo in poznati osnovne opredelitve EUCAST.

	1.
ampicilin	R
amoksicilin+klavulanska kislina - U	R
amoksicilin+klavulanska kislina	R
piperacilin+tazobaktam	R
cefuroksim (parenteralni)	R
cefuroksim (oralni)	R
cefotaksim	R
ceftazidim	R
cefiksim	R
cefepim	R
cefiderocol	R*
ceftolozan+tazobaktam	R >32/4
ceftazidim+avibaktam	R >16/4
ertapenem	R >2
meropenem	R >16
imipenem	R 8
gentamicin	R
amikacin	R
norfloksacin	R
ciprofloksacin	R
levofloksacin	R
trimetoprim+sulfametoksazol	R
tigeciklin	NI 2
nitrofurantoin	NI
kolistin	(S) 0,5

CA!

Trajanje kolonizacije s CPE

- Podobno kot pri nosilstvu ESBL

Two-year prospective evaluation of colonization with extended-spectrum beta-lactamase-producing Enterobacteriaceae: time course and risk factors

LEA PAPST[1], BOJANA BEOVIĆ[1], KATJA SEME[2] & MATEJA PIRŠ[2]

From the [1]Department of Infectious Diseases, University Medical Centre Ljubljana and [2]Institute of Microbiology and Immunology, Faculty of Medicine, University of Ljubljana, Ljubljana, Slovenia

Abstract

Background: We wanted to determine the time course of colonization with extended-spectrum beta-lactamase (ESBL)-producing Enterobacteriaceae (EPE), sites of colonization and risk factors for prolonged colonization with EPE to obtain information for successful infection control measures. *Methods:* Rectal swab, urine, throat swab and other clinically relevant samples (wound swab, tracheal aspirate and sputum) were obtained from each participant. Sets of follow-up samples and data about potential risk factors for prolonged colonization with EPE were collected every 3 months for 2 years. Multivariate analysis using a logistic regression model was performed to identify risk factors for prolonged colonization. *Results:* A total of 114 patients were included in the study, 49 completed the 2-year follow-up. In all, 611 sample sets were collected, 309 (50.6%) of which were positive for ESBL. Of the positive sample sets, 90% had a rectal swab positive for ESBL, the throat swab was positive for ESBL in 17.2% of cases and urine in 36.2% of cases; 10% of positive sample sets had negative rectal swabs with EPE isolated from other sites, most often from urine. Immobility was found to be associated with prolonged carriage (≥12 months) of EPE. After 2 years, 15/49 (30.6%) patients were colonized with EPE. In 12/49 (24.5%) patients, transient negativity was observed. *Conclusions:* We found that prolonged colonization with EPE was common, especially in bedridden patients. Transient negative samples were often observed during the course of colonization. In some patients, urine can be the only positive site from which EPE are isolated.

-

čas po odkritju kolonizacije	Delež koloniziranih
3 mesece	75 %
6 mesecev	55 %
12 mesecev	35 %

Natural history and decolonization strategies for ESBL/carbapenem-resistant Enterobacteriaceae carriage: systematic review and meta-analysis

Haggai Bar-Yoseph[1]*, Khetam Hussein[2], Eyal Braun[1,2] and Mical Paul[2]

Table 3. Natural history of colonization without decolonization treatment among healthcare residents at the defined time points

Subgroup	No. of studies[a]	No. of patients[a]	Pooled rate of colonization (%)[b]	95% CI	I^2 (%)	*P* between subgroups
Total 1 months	12	429	76.7	69.3–82.8	52	
ESBL	6	190	80.2	67.7–88.7	56.9	0.383
CRE	6	239	73.9	64–81.8	47.9	
adult	10	360	74.8	67.7–80.7	39.7	0.306
children	2	69	92.1	46.5–99.4	81.0	
eradication defined as only 1 negative sample	5	86	69.4	59.7–77.7	0.0	0.068
eradication defined as >1 negative sample	7	274	81.5	71.4–88.6	64.7	
presence of MDR-E	9	362	75.0	67.7–81.1	46.5	0.315
persistence same MDR-E	4	128	83.9	65.5–93.5	54.7	
Total 3 months	10	431	75.2	64.6–83.4	74	
ESBL	6	268	76.5	61.1–87.1	76.9	0.852
CRE	4	163	74.6	56.6–86.9	72.7	
adult	8	359	72.5	61.6–81.2	68.9	0.017
children	1	51	96.1	80.7–99.3	0.0	
eradication defined as only 1 negative sample	5	210	69.2	52.3–82.1	62.4	0.168
eradication defined as >1 negative sample	5	221	82.9	67.8–91.8	80.7	
presence of MDR-E	7	294	70.7	56.2–82	65.7	0.496
persistence same MDR-E	4	198	78.0	59–89.7	87.3	
Total 6 months	10	408	55.3	43.7–66.4	76	
ESBL	5	223	56.1	38.7–72.1	83.7	0.945
CRE	5	185	55.2	37.3–71.9	67.3	
adult	7	322	53.0	38.8–66.8	55.6	0.659
children	2	67	67.6	38.4–87.5	95.5	
eradication defined as only 1 negative sample	4	141	43.1	26.9–60.9	4.7	0.079
eradication defined as >1 negative sample	6	267	63.9	48.9–76.5	82.2	
presence of MDR-E	8	302	47.6	35.6–59.8	43.2	0.065
persistence same MDR-E	3	167	68.3	49.9–82.4	90.7	
Total 12 months	12	861	35.2	28.2–42.9	67	
ESBL	7	689	35.7	26.3–46.2	76.9	0.899
CRE	5	172	34.6	22.9–48.5	46.0	
adult	9	782	33.5	26.4–41.5	53.9	0.555
children	2	65	39.4	21.1–61.1	88.0	
eradication defined as only 1 negative sample	6	620	30.9	22.7–40.6	54.1	0.208
eradication defined as >1 negative sample	6	241	39.8	29.9–50.7	62.9	
presence of MDR-E	10	787	32.6	25.8–40.3	60.4	0.328
persistence same MDR-E	3	135	40.0	17.7–53.8	63.3	

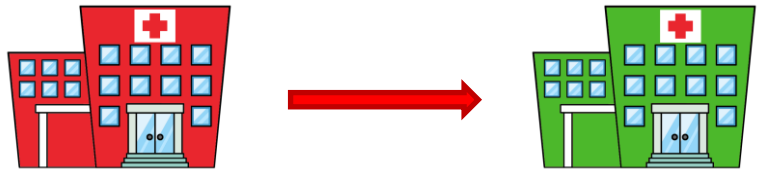
World Health Organization

Table 3.1. Global trends in percentage AMR by infection type: median annual change (2018–2023) and 2023 percentage resistance estimates

Infection type	Antibiotic	Trend	Annual % change[a]	Resistance in 2023 (%)[b]	No. of countries[c]
Bloodstream					
Acinetobacter spp.	Imipenem	Increasing	5.3 (2.7, 8.3)	54.3 (49.3, 59.2)	64
E. coli	Cefotaxime	Stable	1.4 (–0.1, 2.9)	39.0 (33.5, 44.8)	64
	3rd-gen. cephalosporins	Stable	1.3 (–0.1, 2.8)	44.8 (39.3, 50.4)	83
	Imipenem	Increasing	12.5 (9.4, 15.8)	2.4 (1.8, 3.3)	74
K. pneumoniae	Cefotaxime	Stable	–0.3 (–2.5, 1.9)	55.2 (48.5, 61.7)	60
	Imipenem	Increasing	15.3 (12.7, 18.1)	16.7 (13.9, 19.9)	73
Salmonella spp.	Ciprofloxacin	Increasing	9.4 (3.9, 15.3)	18.0 (13.9, 22.9)	65
S. aureus	Methicillin resistance	Stable	–2.5 (–4.5, –0.5)	27.1 (23.5, 31.0)	84
S. pneumoniae	Penicillin G	Stable	–11.0 (–26.8, 7.1)	5.2 (3.6, 7.6)	44
Gastrointestinal					
Salmonella spp.	Ciprofloxacin	Increasing	14.0 (6.5, 22.1)	16.3 (13.8, 19.1)	46
Shigella spp.	Ciprofloxacin	Stable	27.2 (–2.1, 66.1)	29.7 (22.9, 37.5)	19
Urinary tract					
E. coli	Cefotaxime	Stable	–0.3 (–1.5, 1.0)	39.8 (33.9, 46.0)	53
	Imipenem	Increasing	8.5 (6.1, 11.0)	2.6 (2.0, 3.5)	55
K. pneumoniae	Cefotaxime	Stable	–0.4 (–2.3, 1.4)	45.5 (38.6, 52.5)	45
	Imipenem	Increasing	12.9 (10.6, 15.1)	10.9 (8.7, 13.6)	51
Urogenital					
N. gonorrhoeae	Ceftriaxone	Stable	–3.2 (–33.9, 39.2)	0.3 (0.1, 0.6)	38

Kaj lahko naredimo?

- Za **upočasnitev porasta** odpornosti proti antibiotikom in **preprečevanje širjenja** večkratno odpornih bakterijskih klonov z visokim tveganjem za širjenje so bistvenega pomena:
  - **smotrna uporaba antibiotikov**
  - **dobra bolnišnična higiena:** higiena rok, aktivno iskanje nosilcev, ukrepi kontaktne izolacije, razkuževanje opreme in pripomočkov, ki pridejo v stik s koloniziranim bolnikom



  - zmanjševanje možnost vnosa rezistenčnih determinant iz bakterij okoljskega in živalskega izvora.