SURVEILLANCE REPORT

Annual Epidemiological Report for 2014

Antimicrobial resistance (EARS-Net)

Key facts

- Over the last four years (2011 to 2014), the percentages of *Klebsiella pneumoniae* resistant to fluoroquinolones, third-generation cephalosporins and aminoglycosides, as well as combined resistance to all three antimicrobial groups, has increased significantly at the EU/EEA level.
- During the same period, resistance to third-generation cephalosporins and combined resistance to fluoroquinolones, third-generation cephalosporins and aminoglycosides in *Escherichia coli* increased significantly at the EU/EEA level.
- Carbapenems are an important group of last-line antimicrobials for treatment of infections involving multidrug-resistant gram-negative bacteria such as *K. pneumoniae* and *E. coli*. Although carbapenem resistance remains at relatively low levels for most countries, the significant increase of the population-weighted EU/EEA mean percentage of carbapenem resistance in *K. pneumoniae* is cause for serious concern and a threat to patient safety in Europe.
- Antimicrobial resistance in *Acinetobacter* species shows large inter-country variations in Europe. High percentages of isolates with combined resistance to fluoroquinolones, aminoglycosides and carbapenems were reported from the Baltic countries and southern and south-eastern Europe.
- In countries with high levels of multi-drug resistance, including resistance to carbapenems, only a few therapeutic options are available, for example polymyxins. In these countries, the large number of isolates with resistance to polymyxins serves as an important warning that options for the treatment of infected patients are becoming even more limited.
- The percentage of meticillin-resistant *Staphylococcus aureus* (MRSA) showed a significantly decreasing trend at the EU/EEA level between 2011 and 2014, but the decrease was less pronounced compared with the period 2009 to 2012.
- Prudent antimicrobial use and comprehensive infection prevention and control strategies targeting all healthcare sectors (acute care hospitals, long-term care facilities and ambulatory care) are the cornerstones of effective interventions to prevent the selection and transmission of antimicrobial-resistant bacteria.

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Stockholm, July 2018

Methods

This report is based on data for 2014 retrieved from The European Surveillance System (TESSy) on 19 November 2015. TESSy is a system for the collection, analysis and dissemination of data on communicable diseases.

An overview of national disease surveillance systems is available online [1].

A subset of the data used for this report is available through ECDC's online *Surveillance atlas of infectious diseases* [2].

The European Antimicrobial Resistance Surveillance Network (EARS-Net) is the main EU surveillance system for antimicrobial resistance (AMR) in common bacteria causing invasive infections in Europe. The system is based on routine antimicrobial susceptibility testing (AST) results from invasive (blood and cerebrospinal fluid) isolates collected from clinical laboratories by national network representatives in the participating countries. The full EARS-Net panel includes eight bacteria and 45 different antimicrobial agents. This surveillance report presents data from selected bacterium–antimicrobial agent combinations. For a more comprehensive overview, including data on additional bacterium–antimicrobial agent combinations, more detailed description of the surveillance system and discussion on data interpretation, please refer to the EARS-Net 2014 report [3].

Twenty-nine countries, including all EU Member States except Poland, and two EEA countries (Iceland and Norway) reported AMR data for 2014 to EARS-Net before 1 November 2015. However, not all countries reported antimicrobial susceptibility testing (AST) data for all bacterium–antimicrobial agent combinations under surveillance by EARS-Net because the antimicrobial panels used in routine laboratory work differ between countries.

For the purposes of this analysis, an isolate was considered resistant to an antimicrobial agent when tested and interpreted as resistant (R) in accordance with the clinical breakpoint criteria used by the local laboratory. EARS-Net encourages the use of EUCAST breakpoints; however, results based on other interpretive criteria used by the reporting countries are accepted for the analysis. In 2014, approximately 80% of the participating laboratories used EUCAST clinical breakpoints.

A population-weighted EU/EEA mean percentage was determined by applying population-based weights to each country's data before calculating the arithmetic mean for all reporting countries. Only countries reporting data for the last four years were included in the EU/EEA mean. Country weights were used to adjust for imbalances in reporting propensity and population coverage, as the total number of reported isolates per country in most cases does not reflect the population size. The weight applied to each national data point represented the proportion of the country's population out of the total population of all countries included in the calculation. Annual population data were retrieved from the Eurostat online database.

The statistical significance of temporal trends of antimicrobial resistance percentages by country and EU/EEA population-weighted mean was calculated based on data from the last four years. Countries reporting fewer than 20 isolates per year, or not providing data for all years within the considered period, were not included in the analysis. Statistical significance of trends was assessed by the Cochran–Armitage test. An additional sensitivity analysis was performed by repeating the Cochran–Armitage test, including only laboratories that consistently reported for the full four-year period in order to exclude selection bias when assessing the significance of the trends.

Epidemiology

Klebsiella pneumoniae

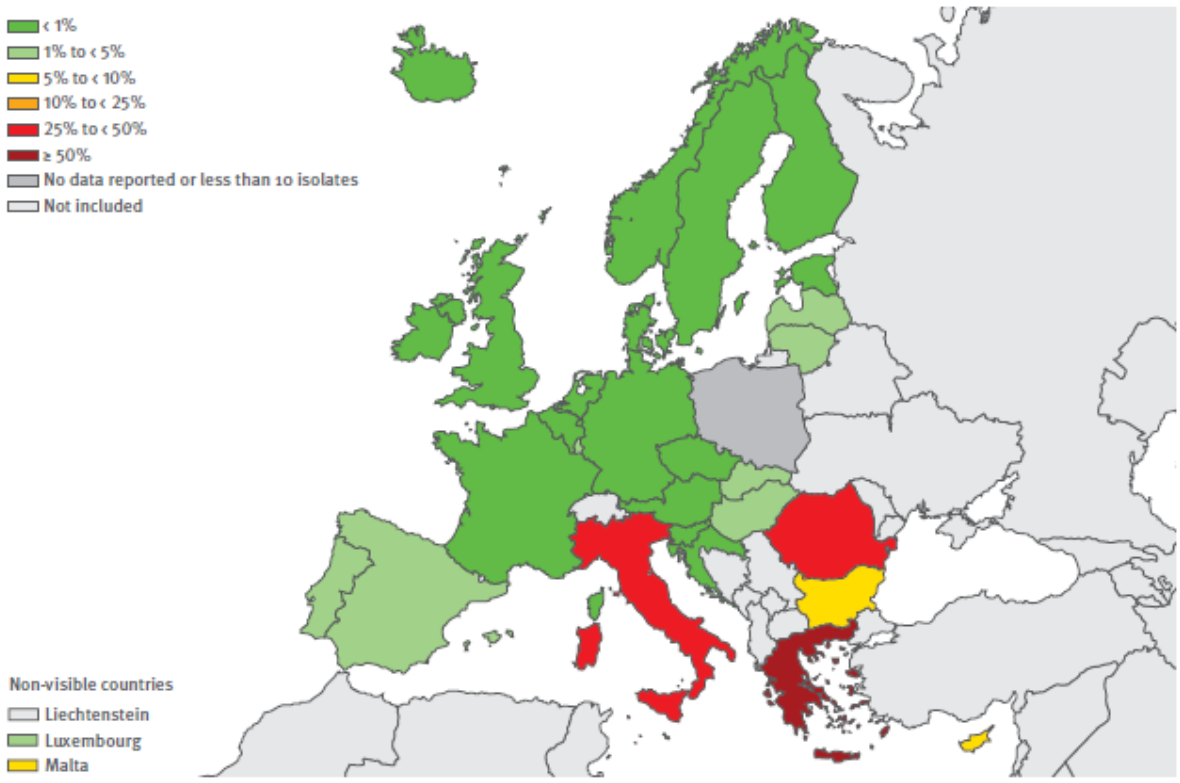
The EU/EEA population-weighted mean percentages of *K. pneumoniae* resistant to fluoroquinolones, to third-generation cephalosporins, to aminoglycosides, and of combined resistance to all three of these antibiotic groups, increased significantly between 2011 and 2014. The increasing trend of combined resistance to fluoroquinolones, third-generation cephalosporins and aminoglycosides from 16.7% in 2011 to 19.6% in 2014 (Table 1) means that for patients who are infected with these multidrug-resistant bacteria only few therapeutic options – among these carbapenems, a last-line group of antibiotics – remain available.

Although carbapenem-resistance percentages remained at low levels for most countries in 2014 (Table 2), resistance to carbapenems at the EU/EEA level significantly increased over the last four years, from a population-weighted mean percentage of 6.0% in 2011 to 7.3% in 2014. Resistance to carbapenems was more frequently reported in *K. pneumoniae* bloodstream infections from south and south-eastern Europe than from other parts of Europe (Figure 2).

Very few therapeutic options are left for patients infected with multidrug-resistant *K. pneumoniae* with additional resistance to carbapenems, and are often limited to combination therapy and to older antibiotics such as polymyxins. Although data on polymyxin susceptibility as part of EARS-Net surveillance are not complete, the fact that some countries – especially countries with already high percentages of carbapenem resistance – report large

numbers of isolates with polymyxin resistance, is an indication of the further loss of effective treatment options for gram-negative bacterial infections.

Figure 1. *Klebsiella pneumoniae*. Percentage (%) of invasive isolates with resistance to carbapenems, EU/EEA countries, 2014



Source: EARS-Net country reports from Austria, Belgium, Bulgaria, Croatia, Cyprus, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Norway, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, and the United Kingdom.

Table 1. *Klebsiella pneumoniae*. Number of isolates tested (N) and percentage of combined resistance to fluoroquinolones, third-generation cephalosporins and aminoglycosides (% R), including 95% confidence intervals (95% CI), EU/EEA countries, 2011–2014

Country	2011			2012			2013			2014			Trend 2011-2014	
	N	%R	(95%CI)	N	%R	(95%CI)	N	%R	(95%CI)	N	%R	(95%CI)		Comment**
Iceland	24	0.0	(0–14)	14	0.0	(0–23)	28	0.0	(0–12)	28	0.0	(0–12)	N/A	
Finland	404	1.2	(0–3)	516	0.2	(0–1)	510	0.4	(0–1)	556	1.4	(1–3)		
Sweden	890	0.9	(0–2)	977	1.4	(1–2)	1235	1.7	(1–3)	623	1.4	(1–3)		
Netherlands	720	4.3	(3–6)	667	2.7	(2–4)	631	2.2	(1–4)	867	2.0	(1–3)		<
Denmark	633	4.9	(3–7)	577	3.1	(2–5)	519	3.5	(2–5)	925	3.1	(2–4)		
United Kingdom	914	2.1	(1–3)	913	2.3	(1–3)	1070	4.9	(4–6)	974	3.2	(2–4)		>
Austria	785	4.1	(3–6)	828	4.2	(3–6)	919	3.8	(3–5)	969	3.4	(2–5)		
Norway	374	0.8	(0–2)	593	1.5	(1–3)	616	1.8	(1–3)	744	3.9	(3–6)		>
Germany	518	6.9	(5–9)	663	6.2	(4–8)	742	6.9	(5–9)	979	5.3	(4–7)		
Ireland	303	3.3	(2–6)	326	3.4	(2–6)	316	7.9	(5–11)	354	7.3	(5–11)		>
Belgium	587	4.9	(3–7)	477	8.2	(6–11)	555	7.0	(5–9)	354	7.9	(5–11)		
Spain	1145	8.3	(7–10)	1150	8.9	(7–11)	1241	11.2	(9–13)	1265	10.0	(8–12)		
Estonia	42	19.0	(9–34)	86	10.5	(5–19)	89	9.0	(4–17)	132	11.4	(7–18)		
Cyprus	83	25.3	(16–36)	65	10.8	(4–21)	68	8.8	(3–18)	80	15.0	(8–25)		
Luxembourg	48	27.1	(15–42)	50	20.0	(10–34)	53	17.0	(8–30)	66	16.7	(9–28)		
Slovenia	232	19.8	(15–26)	254	17.3	(13–23)	245	15.9	(12–21)	233	18.9	(14–25)		
EU/EEA (population-weighted mean)*		**16.7**	**(15–20)**		**17.4**	**(15–20)**		**20.1**	**(18–24)**	**0**	**19.6**	**(18–24)**		>
Portugal	614	20.8	(18–24)	776	25.1	(22–28)	909	21.9	(19–25)	1705	23.0	(21–25)		
France	1647	19.5	(18–21)	1097	19.4	(17–22)	1916	22.9	(21–25)	2175	23.8	(22–26)		>
Malta	52	3.8	(0–13)	57	19.3	(10–32)	69	20.3	(12–32)	101	26.7	(18–36)		>
Hungary	417	46.0	(41–51)	485	37.5	(33–42)	551	32.1	(28–36)	636	28.9	(25–33)		<
Croatia	292	30.5	(25–36)	331	30.8	(26–36)	373	29.8	(25–35)	330	30.9	(26–36)		
Lithuania	137	43.1	(35–52)	184	52.2	(45–60)	144	33.3	(26–42)	154	35.1	(28–43)		<
Czech Republic	1283	36.0	(33–39)	1399	41.8	(39–44)	1291	38.3	(36–41)	1382	38.7	(36–41)		
Latvia	63	33.3	(22–46)	78	42.3	(31–54)	88	39.8	(29–51)	104	41.3	(32–51)		
Bulgaria	120	45.8	(37–55)	127	36.2	(28–45)	138	36.2	(28–45)	151	41.7	(34–50)		
Italy	566	32.9	(29–37)	758	40.2	(37–44)	1403	41.8	(39–44)	1170	44.0	(41–47)		>~
Romania	10	30.0	(7–65)	97	42.3	(32–53)	210	42.9	(36–50)	248	56.0	(50–62)	N/A	
Greece	1630	64.1	(62–66)	1427	59.9	(57–62)	1166	55.4	(52–58)	1063	56.8	(54–60)		<
Slovakia	465	62.4	(58–67)	376	55.3	(50–60)	487	57.9	(53–62)	493	63.3	(59–68)		
Poland	259	37.1	(31–43)	353	48.4	(43–54)	366	52.5	(47–58)	–	–	(–)	N/A	

- No data
N/A: Not applicable as data were not reported for all years, or number of isolates was below 20 in any year during the period
** The EU/EEA population-weighted mean excludes countries not reporting data for all four years*
*** The symbols > and < indicate significant increasing and decreasing trends, respectively. The symbol ~ indicates a significant trend in the overall data, which was not observed when only data from laboratories consistently reporting for all four years were included.*

Source: EARS-Net country reports from Austria, Belgium, Bulgaria, Croatia, Cyprus, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, and the United Kingdom.

Table 2. *Klebsiella pneumoniae*. Number of invasive isolates tested (N) and percentage resistant to carbapenems (% R), including 95% confidence intervals (95% CI), EU/EEA countries, 2011–2014

Country	2011			2012			2013			2014			Trend 2011-2014	
	N	%R	(95% CI)	N	%R	(95% CI)	N	%R	(95% CI)	N	%R	(95% CI)		Comment**
Estonia	73	0.0	(0–5)	79	1.3	(0–7)	74	2.7	(0–9)	92	0.0	(0–4)		
Finland	404	0.0	(0–1)	536	0.0	(0–1)	546	0.0	(0–1)	583	0.0	(0–1)		
Iceland	24	0.0	(0–13)	16	0.0	(0–19)	30	0.0	(0–11)	25	0.0	(0–4)	N/A	
Norway	443	0.0	(0–1)	623	0.5	(0–1)	645	0.2	(0–1)	746	0.0	(0–0)		
Sweden	941	0.0	(0–0)	977	0.0	(0–0)	1269	0.0	(0–0)	978	0.0	(0–0)		
Czech Republic	1193	0.1	(0–0)	1307	0.3	(0–1)	1133	0.5	(0–1)	1148	0.1	(0–0)		
Denmark	589	0.0	(0–1)	680	0.3	(0–1)	645	0.2	(0–1)	830	0.2	(0–1)		
Netherlands	722	0.3	(0–1)	684	0.1	(0–1)	646	0.2	(0–1)	903	0.2	(0–1)		
Belgium	646	0.3	(0–1)	545	0.7	(0–2)	618	0.3	(0–1)	429	0.5	(0–2)		
France	1640	0.0	(0–0)	1627	0.5	(0–1)	1842	0.7	(0–1)	2103	0.5	(0–1)		>
Austria	610	0.2	(0–1)	738	0.8	(0–2)	910	1.2	(1–2)	971	0.6	(0–1)		
Ireland	302	0.3	(0–2)	338	0.0	(0–1)	317	0.3	(0–2)	353	0.6	(0–2)		
Germany	512	0.0	(0–1)	661	0.0	(0–1)	743	0.7	(0–2)	1006	0.7	(0–1)		>
United Kingdom	825	0.4	(0–1)	888	0.5	(0–1)	1051	0.5	(0–1)	1068	0.8	(0–2)		
Croatia	299	0.0	(0–1)	331	0.0	(0–1)	376	0.5	(0–2)	334	0.9	(0–3)		>
Slovenia	232	0.0	(0–2)	254	0.4	(0–2)	245	0.4	(0–2)	233	0.9	(0–3)		
Hungary	413	1.9	(1–4)	481	2.9	(2–5)	531	1.7	(1–3)	621	1.1	(0–2)		
Lithuania	19	0.0	(0–18)	185	0.0	(0–2)	144	0.0	(0–3)	154	1.3	(0–5)	N/A	
Luxembourg	48	0.0	(0–7)	48	0.0	(0–7)	53	1.9	(0–10)	66	1.5	(0–8)		
Latvia	65	0.0	(0–6)	77	0.0	(0–5)	92	0.0	(0–4)	118	1.7	(0–6)		
Portugal	580	0.3	(0–1)	749	0.7	(0–2)	904	1.8	(1–3)	1701	1.8	(1–3)		>
Spain	1144	0.3	(0–1)	1152	0.8	(0–1)	1241	1.6	(1–2)	1266	2.3	(2–3)		>
Slovakia	434	0.7	(0–2)	331	6.3	(4–10)	342	0.6	(0–2)	456	2.6	(1–5)		
Cyprus	83	15.7	(9–25)	65	9.2	(3–19)	68	5.9	(2–14)	80	5.0	(1–12)		<
Bulgaria	116	0.0	(0–3)	108	1.9	(0–7)	129	0.0	(0–3)	139	7.2	(4–13)		>
EU/EEA (population-weighted mean)*		**6.0**	**(4–8)**		**6.4**	**(5–8)**		**8.4**	**(7–10)**		**7.3**	**(6–9)**		**>**
Malta	52	3.8	(0–13)	57	3.5	(0–12)	69	5.8	(2–14)	101	9.9	(5–17)		
Romania	10	0.0	(0–31)	102	13.7	(8–22)	215	20.5	(15–26)	257	31.5	(26–38)	N/A	
Italy	615	26.7	(23–38)	845	29.1	(26–32)	1453	34.3	(32–37)	1315	32.9	(30–36)		>~
Greece	1636	68.2	(66–70)	1460	60.5	(58–63)	1209	59.4	(57–62)	1088	62.3	(59–65)		<
Poland	376	0.5	(0–2)	359	0.8	(0–2)	370	0.8	(0–2)	–	–	(–)	N/A	

- No data
N/A: Not applicable as data were not reported for all years, or number of isolates was below 20 in any year during the period
** The EU/EEA population-weighted mean excludes countries not reporting data for all four years*
*** The symbols > and < indicate significant increasing and decreasing trends, respectively. The symbol ~ indicates a significant trend in the overall data, which was not observed when only data from laboratories consistently reporting for all four years were included.*

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Escherichia coli

For *Escherichia coli*, resistance to third-generation cephalosporins increased significantly at the EU/EEA level, from 9.6% in 2011 to 12.0% in 2014 (Table 3). Combined resistance to third-generation cephalosporins, fluoroquinolones and aminoglycosides (Table 4) also increased significantly at the EU/EEA level, from 3.8% in 2011 to 4.8% in 2014. Several countries reported statistically significant increasing trends for these types of resistance during 2011–2014. The highest percentages of combined resistance to third-generation cephalosporins, fluoroquinolones and aminoglycosides were reported form southern and south-eastern Europe (Figure 2).

Resistance to carbapenems in *E. coli* remained low in the EU/EEA in 2014.

Figure 2. *Escherichia coli:* percentage of invasive isolates with combined resistance to third-generation cephalosporins, fluoroquinolones and aminoglycosides, EU/EEA countries, 2014

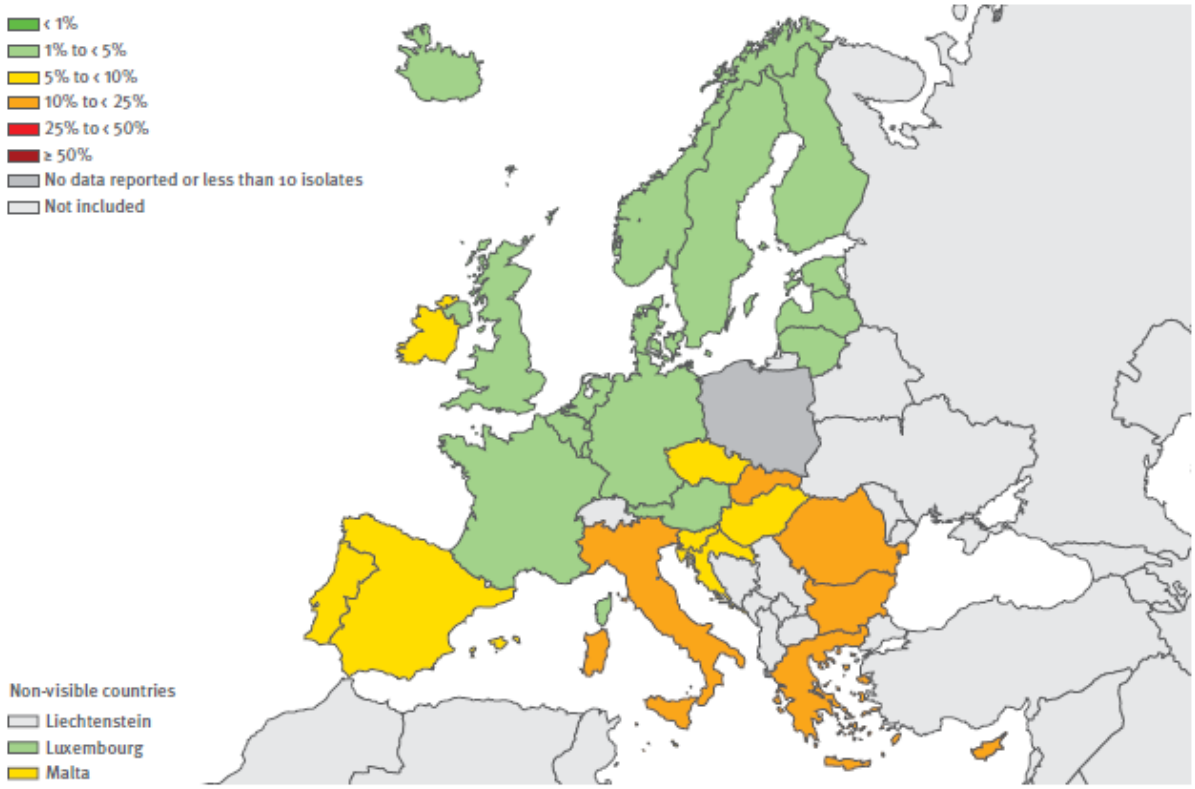

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Table 3. *Escherichia coli*. Number of isolates tested (N) and percentage with resistance to third-generation cephalosporins (% R), including 95% confidence intervals (95% CI), EU/EEA countries, 2011-2014

Country	2011			2012			2013			2014			Trend 2011-2014	
	N	%R	(95% CI)	N	%R	(95% CI)	N	%R	(95% CI)	N	%R	(95% CI)		Comment**
Iceland	130	6.2	(3–12)	138	5.1	(2–10)	121	5.0	(2–10)	152	3.3	(1–8)		
Finland	3020	5.0	(4–6)	3162	6.2	(5–7)	3689	7.1	(6–8)	4009	5.5	(5–6)		
Sweden	5102	3.6	(3–4)	5537	4.5	(4–5)	7532	5.2	(5–6)	6546	5.6	(5–6)		>
Netherlands	4408	5.7	(5–6)	4702	6.0	(5–7)	4740	5.8	(5–7)	6497	5.7	(5–6)		
Norway	2523	3.6	(3–4)	3019	4.9	(4–6)	3077	5.5	(5–6)	3421	5.8	(5–7)		>
Denmark	2532	8.5	(7–10)	2519	7.9	(7–9)	2451	8.1	(7–9)	4410	7.0	(6–8)		<~
Lithuania	385	7.0	(5–10)	462	4.8	(3–7)	432	7.6	(5–11)	594	8.1	(6–11)		
Estonia	90	12.2	(6–21)	305	7.9	(5–11)	340	7.4	(5–11)	410	9.3	(7–12)		
Austria	3160	9.1	(8–10)	3710	8.7	(8–10)	4376	9.8	(9–11)	4739	9.4	(9–10)		
Belgium	3985	6.0	(5–7)	4097	6.9	(6–8)	4051	8.0	(7–9)	2802	9.7	(9–11)		>
France	8479	8.2	(8–9)	9563	10.0	(9–11)	10154	9.5	(9–10)	10349	9.9	(9–11)		>
United Kingdom	5182	9.6	(9–10)	5663	13.1	(12–14)	6586	14.7	(14–16)	6219	10.3	(10–11)		
Germany	3642	8.0	(7–9)	4186	8.8	(8–10)	5249	10.7	(10–12)	6246	10.5	(10–11)		>
Ireland	2166	9.0	(8–10)	2288	9.2	(8–10)	2480	10.6	(9–12)	2691	10.7	(10–12)		>
Croatia	983	9.6	(8–12)	906	7.5	(6–9)	1040	8.8	(7–11)	1079	10.8	(9–13)		
Malta	219	12.8	(9–18)	216	13.9	(10–19)	248	8.9	(6–13)	279	10.8	(7–15)		
Latvia	132	15.9	(10–23)	154	13.0	(8–19)	136	14.0	(9–21)	165	10.9	(7–17)		
Luxembourg	353	8.2	(6–12)	334	11.4	(8–15)	301	10.6	(7–15)	368	12.0	(9–16)		
EU/EEA (population-weighted mean)*		**9.6**	**(9–11)**		**11.9**	**(11–13)**		**12.7**	**(12–14)**		**12.0**	**(11–13)**		>
Spain	5600	12.0	(11–13)	5672	13.5	(13–14)	5932	13.3	(12–14)	5821	12.3	(12–13)		
Slovenia	1002	8.8	(7–11)	1168	9.5	(8–11)	1224	8.7	(7–10)	1216	12.7	(11–15)		>
Czech Republic	2684	11.4	(10–13)	2812	11.5	(10–13)	2954	13.1	(12–14)	2978	14.0	(13–15)		>
Hungary	1224	15.1	(13–17)	1411	17.4	(15–20)	1437	18.9	(17–21)	1619	16.4	(15–18)		
Portugal	1901	11.3	(10–13)	2154	13.5	(12–15)	2678	14.9	(14–16)	5024	16.4	(15–17)		>
Greece	1435	14.9	(13–17)	1393	16.2	(14–18)	1255	17.2	(15–19)	1122	21.0	(19–24)		>~
Italy	1870	19.8	(18–22)	2997	26.3	(25–28)	3990	26.2	(25–28)	3694	28.7	(27–30)		>~
Cyprus	138	36.2	(28–45)	176	31.8	(25–39)	162	38.9	(31–47)	153	28.8	(22–37)		
Romania	95	21.1	(13–31)	191	25.1	(19–32)	298	22.8	(18–28)	306	29.4	(24–35)		
Slovakia	740	30.9	(28–34)	693	30.7	(27–34)	807	29.7	(27–33)	889	31.8	(29–35)		
Bulgaria	179	22.9	(17–30)	223	38.1	(32–45)	187	39.6	(33–47)	218	40.4	(34–47)		>
Poland	938	11.7	(10–14)	1037	12.9	(11–15)	1036	10.9	(9–13)	–	–	(–)	N/A	

- No data
N/A: Not applicable as data were not reported for all years, or number of isolates was below 20 in any year during the period
** The EU/EEA population-weighted mean excludes countries not reporting data for all four years*
*** The symbols > and < indicate significant increasing and decreasing trends, respectively. The symbol ~ indicates a significant trend in the overall data, which was not observed when only data from laboratories consistently reporting for all four years were included.*

Source: EARS-Net country reports from Austria, Belgium, Bulgaria, Croatia, Cyprus, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, and the United Kingdom.

Table 4. *Escherichia coli*. Number of isolates tested (N) and percentage of combined resistance to fluoroquinolones, third-generation cephalosporins and aminoglycosides (% R), including 95% confidence intervals (95% CI), EU/EEA countries, 2011–2014

Country	2011			2012			2013			2014			Trend 2011-2014	
	N	%R	(95% CI)	N	%R	(95% CI)	N	%R	(95% CI)	N	%R	(95% CI)		Comment**
Iceland	120	0.8	(0–5)	134	1.5	(0–5)	116	0.9	(0–5)	141	1.4	(0–5)		
Denmark	2529	3.0	(2–4)	2285	2.6	(2–3)	2377	2.2	(2–3)	4406	1.9	(1–2)		<
Norway	2259	1.2	(1–2)	2835	1.9	(1–3)	2971	2.5	(2–3)	3413	2.0	(2–2)		> ~
Sweden	3915	1.4	(1–2)	5532	1.8	(1–2)	7094	2.0	(2–2)	4203	2.0	(2–2)		> ~
Netherlands	4400	2.2	(2–3)	4675	1.8	(1–2)	4722	1.9	(2–2)	6427	2.1	(2–3)		
Finland	3020	2.5	(2–3)	2993	3.1	(3–4)	3433	3.2	(3–4)	3787	2.2	(2–3)		
Latvia	131	9.2	(5–15)	152	6.6	(3–12)	134	4.5	(2–9)	163	2.5	(1–6)		<
Lithuania	378	2.4	(1–4)	455	1.3	(0–3)	429	2.1	(1–4)	588	2.6	(1–4)		
Austria	3121	2.6	(2–3)	3579	2.5	(2–3)	4260	3.2	(3–4)	4617	2.7	(2–3)		
Germany	3631	3.6	(3–4)	4179	3.2	(3–4)	5241	2.7	(2–3)	6158	3.0	(3–3)		
Estonia	89	1.1	(0–6)	303	1.7	(1–4)	335	3.3	(2–6)	405	3.5	(2–6)		
France	8428	2.6	(2–3)	5655	3.3	(3–4)	10068	3.2	(3–4)	10305	3.5	(3–4)		>
Belgium	3331	1.4	(1–2)	3330	1.8	(1–2)	3748	2.3	(2–3)	2227	3.7	(3–5)		>
Luxembourg	353	2.8	(1–5)	334	2.7	(1–5)	287	2.1	(1–4)	368	4.1	(2–7)		
United Kingdom	5005	3.6	(3–4)	5577	4.2	(4–5)	6536	4.4	(4–5)	6190	4.4	(4–5)		>
EU/EEA (population-weighted mean)*		**3.8**	**(3–4)**		**4.9**	**(4–6)**		**4.6**	**(4–5)**		**4.8**	**(4–6)**		>
Ireland	2148	3.6	(3–4)	2283	4.0	(3–5)	2478	4.9	(4–6)	2689	5.0	(4–6)		>
Spain	5594	4.9	(4–6)	5651	5.9	(5–7)	5922	5.8	(5–6)	5816	5.3	(5–6)		
Croatia	947	2.6	(2–4)	889	2.8	(2–4)	1015	3.5	(2–5)	1070	6.0	(5–8)		>
Czech Republic	2667	3.7	(3–4)	2809	4.5	(4–5)	2953	4.9	(4–6)	2976	6.4	(6–7)		>
Malta	219	9.6	(6–14)	216	8.3	(5–13)	248	5.2	(3–9)	279	6.8	(4–10)		
Slovenia	1002	4.1	(3–6)	1168	5.1	(4–7)	1224	4.8	(4–6)	1216	7.2	(6–9)		>
Hungary	1209	8.3	(7–10)	1387	10.5	(9–12)	1422	11.0	(9–13)	1599	8.3	(7–10)		
Portugal	1891	7.5	(6–9)	2152	9.2	(8–11)	2677	8.5	(7–10)	4990	8.6	(8–9)		
Greece	1431	10.8	(9–13)	1368	10.7	(9–12)	1235	10.4	(9–12)	1104	10.9	(9–13)		
Cyprus	137	18.2	(12–26)	176	14.8	(10–21)	162	20.4	(14–27)	153	13.1	(8–19)		
Italy	1745	10.3	(9–12)	2686	14.4	(13–16)	3884	12.2	(11–13)	3441	13.8	(13–15)		> ~
Romania	50	10.0	(3–22)	179	15.6	(11–22)	292	9.2	(6–13)	298	14.4	(11–19)		
Slovakia	739	12.9	(11–15)	692	13.6	(11–16)	807	17.2	(15–20)	887	17.1	(15–20)		>
Bulgaria	179	10.1	(6–15)	223	16.1	(12–22)	187	19.8	(14–26)	213	19.7	(15–26)		> ~
Poland	902	4.0	(3–5)	1011	5.8	(4–7)	999	5.2	(4–7)	–	–	(–)	N/A	

- No data
N/A: Not applicable as data were not reported for all years, or number of isolates was below 20 in any year during the period
** The EU/EEA population-weighted mean excludes countries not reporting data for all four years*
*** The symbols > and < indicate significant increasing and decreasing trends, respectively. The symbol ~ indicates a significant trend in the overall data, which was not observed when only data from laboratories consistently reporting for all four years were included.*

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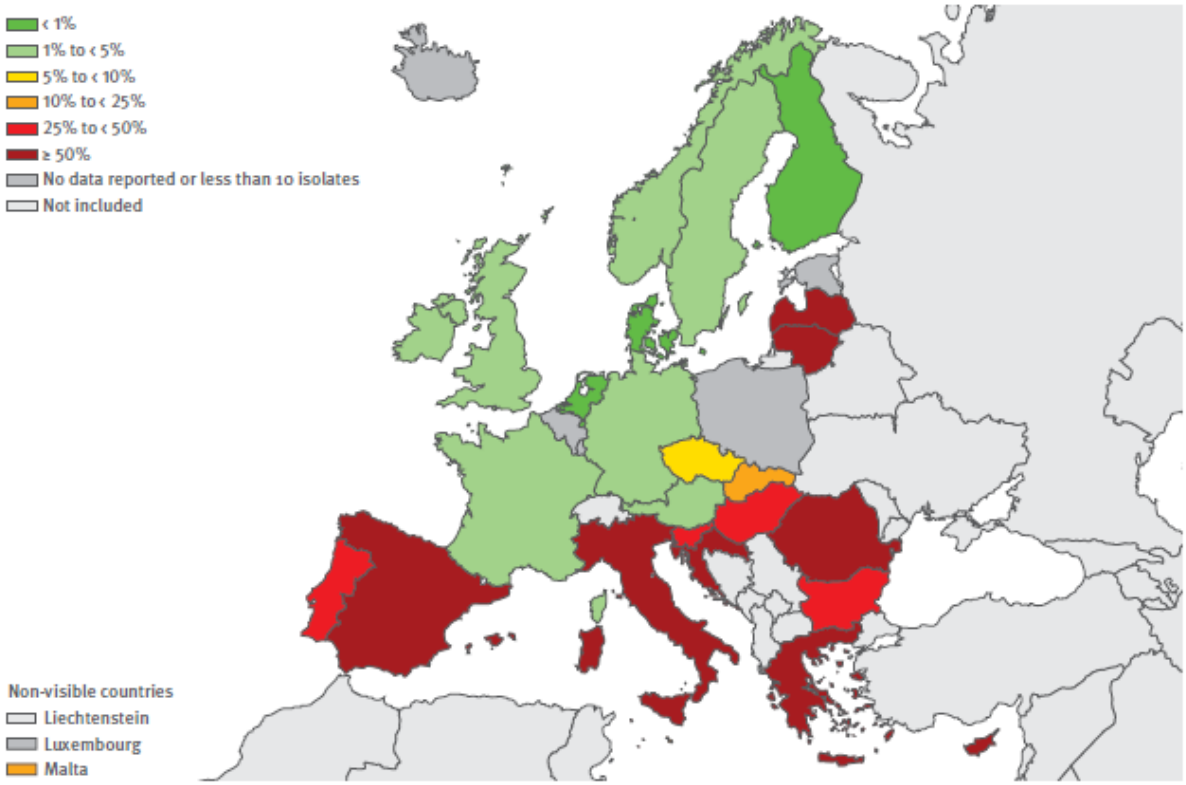
Acinetobacter species

Antimicrobial resistance in *Acinetobacter* species showed large variations across Europe, with generally very high resistance percentages reported from the Baltic countries, southern and south-eastern Europe. Combined resistance to fluoroquinolones, aminoglycosides and carbapenems was the most frequently reported resistance phenotype in 2014 and accounted for almost half of the reported isolates. Eight out of the 25 countries reporting susceptibility results for 10 or more isolates in 2014 had percentages for this type of combined resistance of 50% or higher, a clear indication that options for the treatment of patients infected with *Acinetobacter* species in these countries are very limited (Table 5, Figure 3).

Resistance to polymyxins was observed in 4% of *Acinetobacter* species isolates, with a vast majority reported from southern Europe. These results should be interpreted with caution due to the low number of isolates tested and differences in laboratory methodology to determine susceptibility. However, the high levels of resistance to multiple antimicrobials reported from several EU/EEA countries are of great concern, especially when resistance to carbapenems is already high and resistance to polymyxins is being reported.

Figure 3. *Acinetobacter* species: percentage of invasive isolates with combined resistance to fluoroquinolones, aminoglycosides and carbapenems, EU/EEA, 2014



Source: EARS-Net country reports from Austria, Bulgaria, Croatia, Cyprus, the Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Malta, the Netherlands, Norway, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, and the United Kingdom.

Table 5. *Acinetobacter* spp. Number of isolates tested (N) and percentage combined resistance to fluoroquinolones, aminoglycosides and carbapenems (% R), including 95% confidence intervals (95% CI), by country, EU/EEA countries, 2012–2014

Country	2012			2013			2014			
	N	%R	(95% CI)	N	%R	(95% CI)	N	%R	(95% CI)	
Denmark	58	8.6	(3–19)	57	1.8	(0–9)	49	0.0	(0–7)	
Finland	–	–	(-)	34	0.0	(0–10)	30	0.0	(0–12)	
Netherlands	10	0.0	(0–31)	64	1.6	(0–8)	69	0.0	(0–5)	
Ireland	–	–	(-)	84	0.0	(0–4)	79	1.3	(0–7)	
France	272	4.0	(2–7)	389	4.1	(2–7)	391	1.5	(1–3)	
United Kingdom	79	1.3	(0–7)	149	1.3	(0–5)	119	1.7	(0–6)	
Germany	119	4.2	(1–10)	172	5.2	(2–10)	188	2.1	(1–5)	
Austria	–	–	(-)	51	5.9	(1–16)	74	2.7	(0–9)	
Sweden	–	–	(-)	71	5.6	(2–14)	36	2.8	(0–15)	
Norway	25	0.0	(0–14)	36	0.0	(0–10)	33	3.0	(0–16)	
Czech Republic	–	–	(-)	91	4.4	(1–11)	59	5.1	(1–14)	
Malta	5	#	(#)	7	#	(#)	10	10.0	(0–45)	
Slovakia	–	–	(-)	142	31.7	(24–40)	161	24.8	(18–32)	
Slovenia	25	12.0	(3–31)	25	20.0	(7–41)	34	26.5	(13–44)	
Portugal	168	64.3	(57–72)	222	56.3	(50–63)	260	39.2	(33–45)	
Hungary	394	41.6	(37–47)	466	48.7	(44–53)	438	42.0	(37–47)	
Bulgaria	58	32.8	(21–46)	86	39.5	(29–51)	97	48.5	(38–59)	
Spain	–	–	(-)	70	70.0	(64–83)	78	56.4	(45–68)	
Latvia	–	–	(-)	–	–	(-)	52	61.5	(47–75)	
Lithuania	–	–	(-)	–	–	(-)	66	66.7	(54–78)	
Cyprus	23	47.8	(27–69)	33	60.6	(42–77)	57	73.7	(60–84)	
Romania	54	50.0	(36–64)	137	74.5	(66–82)	121	77.7	(69–85)	
Croatia	–	–	(-)	112	86.6	(79–92)	163	85.9	(80–91)	
Italy	217	77.4	(71–82)	453	79.0	(75–83)	439	86.8	(83–90)	
Greece	1203	74.5	(72–77)	810	85.2	(83–88)	794	86.9	(84–89)	
Belgium	–	–	(-)	3	#	(#)	4	#	(#)	
Iceland	2	#	(#)	0	#	(#)	3	#	(#)	
Luxembourg	5	#	(#)	1	#	(#)	6	#	(#)	
Poland	197	35.0	(28–42)	184	46.7	(39–54)	–	–	(-)	

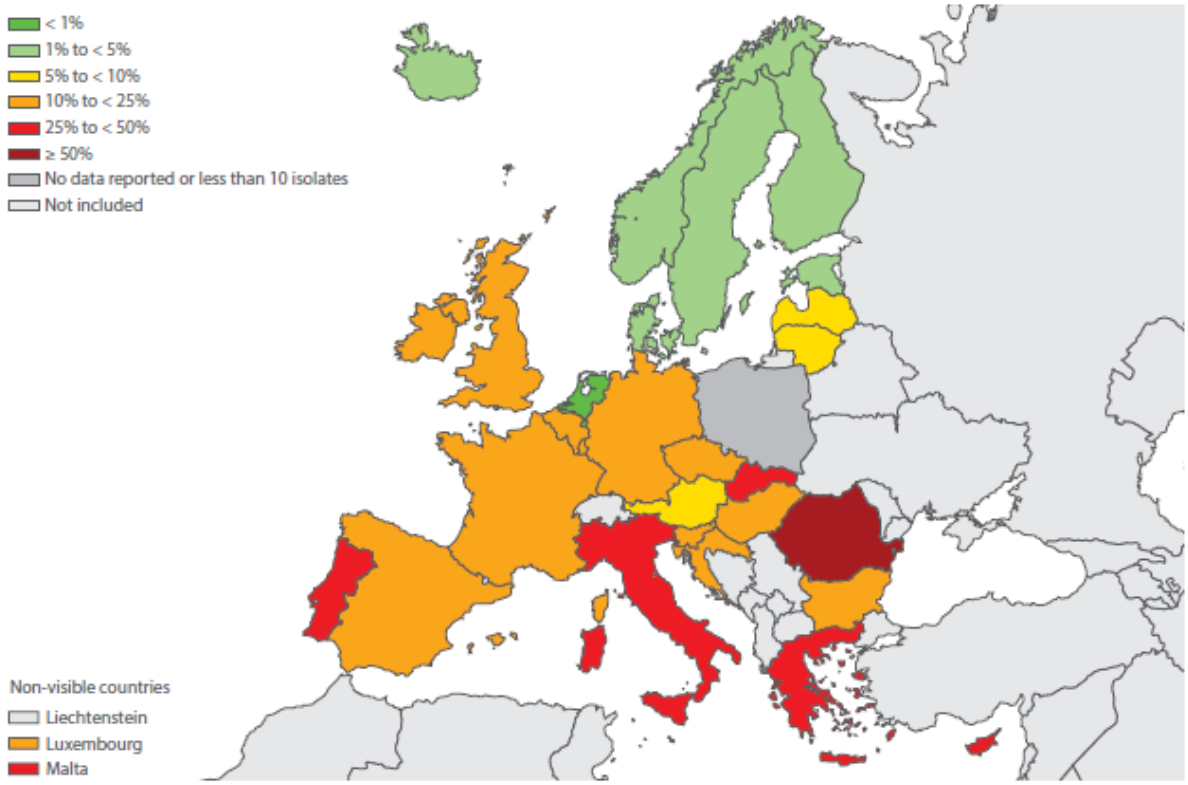
- : No data
N/A: Not applicable as data were not reported for all years, or number of isolates was below 20 in any year during the period
#: Percentage resistance not calculated as number of isolates was below 10

Source: EARS-Net country reports from Austria, Belgium, Bulgaria, Croatia, Cyprus, the Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, and the United Kingdom.

Meticillin-resistant *Staphylococcus aureus* (MRSA)

As in previous years, large inter-country variations in the percentage of meticillin-resistant *Staphylococcus aureus* (MRSA) were observed across Europe in 2014 (Figure 4). The EU/EEA population-weighted mean percentage decreased significantly from 18.6% in 2011 to 17.4% in 2014 (Table 6), but the decrease was less pronounced compared with that observed for the period 2009–2012.

Figure 4. *Staphylococcus aureus*: Percentage (%) of invasive isolates with resistance to meticillin (MRSA), EU/EEA countries, 2014



Source: EARS-Net country reports from: Austria, Belgium, Bulgaria, Croatia, Cyprus, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Norway, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, and the United Kingdom.

Table 6. *Staphylococcus aureus*. Number of isolates tested (N) and percentage with resistance to meticillin (MRSA) (%R), including 95% confidence intervals (95% CI), EU/EEA countries, 2011–2014

Country	2011			2012			2013			2014			Trend 2011-2014	
	N	%R	(95% CI)	N	%R	(95% CI)	N	%R	(95% CI)	N	%R	(95% CI)		Comment**
Netherlands	1801	1.4	(1–2)	1944	1.3	(1–2)	2062	1.2	(1–2)	2524	0.9	(1–1)		
Norway	1223	0.3	(0–1)	1430	1.3	(1–2)	1473	0.7	(0–1)	1544	1.0	(1–2)		
Sweden	3751	1.0	(1–1)	3262	0.7	(0–1)	4099	1.0	(1–1)	2745	1.0	(1–1)		
Denmark	1452	1.2	(1–2)	1431	1.3	(1–2)	1685	1.7	(1–2)	1874	2.5	(2–3)		>
Finland	1319	3.2	(2–4)	1409	2.1	(1–3)	1555	1.7	(1–3)	1831	2.6	(2–3)		
Estonia	116	1.7	(0–6)	104	7.7	(3–15)	170	3.5	(1–8)	223	3.1	(1–6)		
Iceland	71	2.8	(0–10)	58	1.7	(0–9)	69	0.0	(0–5)	61	3.3	(0–11)		
Austria	1966	7.4	(6–9)	2164	7.7	(7–9)	2534	9.2	(8–10)	2651	7.8	(7–9)		
Lithuania	278	5.4	(3–9)	323	10.2	(7–14)	267	9.7	(6–14)	383	7.8	(5–11)		
Latvia	192	9.9	(6–15)	211	9.0	(6–14)	172	7.0	(4–12)	220	8.2	(5–13)		
United Kingdom	3408	13.6	(13–15)	2679	14.0	(13–15)	2117	13.7	(12–15)	2395	11.3	(11–13)		<
Germany	2388	16.2	(15–18)	2563	15.4	(14–17)	3070	12.7	(12–14)	3146	11.8	(11–13)		<
Luxembourg	127	20.5	(14–29)	131	15.3	(10–23)	135	8.9	(5–15)	125	12.0	(7–19)		<
Czech Republic	1555	14.5	(13–16)	1611	13.0	(11–15)	1707	13.2	(12–15)	1695	13.0	(11–15)		
Slovenia	464	7.1	(5–10)	445	10.3	(8–14)	465	9.0	(7–12)	495	13.1	(10–16)		>
Belgium	1744	17.4	(16–19)	1568	16.6	(15–19)	1612	16.9	(15–19)	988	13.4	(11–16)		<~
France	4716	20.1	(19–21)	5228	19.2	(18–20)	5431	17.0	(16–18)	5484	17.4	(16–18)		<
EU/EEA (population-weighted mean)*		**18.6**	**(17–20)**		**18.6**	**(17–20)**		**18.1**	**(17–20)**		**17.4**	**(16–19)**		<
Ireland	1057	23.7	(21–26)	1038	22.6	(20–25)	1069	19.9	(18–22)	1075	19.4	(17–22)		<
Bulgaria	214	22.4	(17–29)	227	19.8	(15–26)	214	19.2	(14–25)	216	20.8	(16–27)		
Croatia	415	27.7	(23–32)	403	21.3	(17–26)	520	24.0	(20–28)	484	21.3	(18–25)		
Spain	1950	22.5	(21–24)	1899	24.2	(22–26)	1777	22.6	(21–25)	1920	22.1	(20–24)		
Hungary	1156	26.2	(24–29)	1143	24.8	(22–27)	1200	24.0	(22–27)	1279	23.1	(21–25)		
Slovakia	566	26.1	(23–30)	474	21.7	(18–26)	552	27.0	(23–31)	640	28.0	(25–32)		
Italy	1261	38.2	(33–38)	1636	35.2	(33–38)	2394	35.8	(34–38)	2133	33.6	(32–36)		<
Cyprus	113	41.6	(32–51)	165	35.2	(28–43)	157	32.5	(25–40)	136	36.0	(28–45)		
Greece	784	39.2	(36–43)	876	41.0	(38–44)	757	40.3	(37–44)	556	37.1	(35–42)		
Malta	130	49.2	(40–58)	102	47.1	(37–57)	114	51.8	(42–61)	82	42.7	(32–54)		
Portugal	1307	54.6	(52–57)	1455	53.8	(51–56)	2390	46.8	(45–49)	3193	47.4	(46–49)		<
Romania	109	49.5	(40–59)	229	53.3	(47–60)	383	64.5	(59–69)	316	56.0	(50–62)		
Poland	860	24.3	(21–27)	781	25.5	(22–29)	743	16.0	(13–19)	–	–	(–)	N/A	

- No data
N/A: Not applicable as data were not reported for all years, or number of isolates was below 20 in any year during the period
** The EU/EEA population-weighted mean excludes countries not reporting data for all four years*
*** The symbols > and < indicate significant increasing and decreasing trends, respectively. The symbol ~ indicates a significant trend in the overall data, which was not observed when only data from laboratories consistently reporting for all four years were included.*

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Discussion

The AMR situation varies widely in the EU/EEA, depending on the bacterium, antimicrobial group and geographical region. For several bacterium–antimicrobial group combinations, a north-to-south and west-to-east gradient is evident in Europe. In general, lower resistance percentages are reported by countries in northern Europe, and higher percentages by countries in southern and eastern Europe. These differences are most likely related to inter-country differences in antimicrobial use, infection prevention and control practices, and utilisation of healthcare resources. While antimicrobial use exerts ecological pressure on bacteria and contributes to emergence and selection of AMR, poor infection prevention, insufficient control practices, and inadequate sanitary conditions favour the further spread of these bacteria.

For gram-negative bacteria such as *K. pneumoniae*, *E. coli* and *Acinetobacter* species, the AMR situation is especially worrying with high, and in many cases increasing resistance percentages, reported from many parts of Europe. The increasing trends of combined resistance to key antimicrobial groups means that for patients who are infected with these multidrug-resistant bacteria, only few therapeutic options remain available.

Among these are the carbapenems, a last-line group of antimicrobials. The increase in carbapenem resistance in *K. pneumoniae* observed in the EARS-Net surveillance data is most likely the result of an increase in isolates producing a carbapenemase, as previously reported from the ECDC-funded European Survey on Carbapenemase-Producing Enterobacteriaceae (EuSCAPE) [5]. The continuous spread of carbapenemase-producing Enterobacteriaceae (CPE), mostly *K. pneumoniae*, represents a serious threat to healthcare and patient safety in European hospitals, to which many European countries have reacted by intensifying their containment efforts.

ECDC issued two risk assessments targeting CPE during 2011 [6,7] emphasising the need for implementation of infection control measures such as active patient screening and additional hygiene precautions when caring for CPE-positive patients. These were complemented in 2014 with an ECDC systematic review of the effectiveness of infection control measures to prevent the transmission of CPE through cross-border transfer of patients [8]. Although many European countries recently upgraded their level of CPE management, gaps still remain and many countries lack national guidance for CPE infection prevention and control [5].

Very few therapeutic options are left for patients infected with multidrug-resistant gram-negative bacteria with additional resistance to carbapenems. These options are often limited to combination therapy and to older antimicrobials such as polymyxins. Although data on polymyxin susceptibility as part of EARS-Net surveillance are incomplete, the fact that some countries, especially countries with already high percentages of carbapenem resistance, report large numbers of isolates with polymyxin resistance is an indication of the further loss of effective treatment options for gram-negative bacterial infections.

The decline in MRSA has been less pronounced in recent years compared with that observed for the period 2009–2012, but the decreasing MRSA trend continued in eight of 29 countries, including countries with both low and high national MRSA percentages. Despite this positive development, MRSA remains an important public health problem in Europe, as seven out of 29 countries reported MRSA percentages above 25%. To continue reducing the spread of MRSA in Europe, comprehensive MRSA strategies targeting all healthcare sectors (acute care, long-term care and ambulatory care) remain essential. Despite MRSA still being a major cause of healthcare-associated infections, community-associated MRSA are increasingly being reported from many parts of the world, including Europe. In addition, the proportion of community-onset infections caused by MRSA clones usually associated with healthcare-associated infections has increased, indicating a transfer of healthcare-associated MRSA clones into the community [9].

Public health conclusions

AMR is a serious threat to public health in Europe. For invasive bacterial infections, prompt treatment with effective antimicrobial agents is especially important as it is one of the single most effective interventions to reduce the risk of fatal outcome. The ongoing increase in resistance to a number of key antimicrobial groups in invasive bacterial isolates reported to EARS-Net is therefore of great concern and constitutes a serious threat to patient safety in Europe. Prudent antimicrobial use, comprehensive infection prevention, and control strategies targeting all healthcare sectors are the cornerstones of effective interventions to prevent the selection and transmission of bacteria resistant to antimicrobial agents.

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