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European Surveillance of Antimicrobial Consumption (ESAC): quality appraisal of antibiotic use in Europe

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Objectives: To assess quality of outpatient antibiotic use in Europe in 2009 based on the 12 European Surveillance of Antimicrobial Consumption (ESAC) drug-specific quality indicators and to evaluate changes in quality between 2004 and 2009.

Methods: Quality of outpatient antibiotic use in 2009 was compared between 32 countries by calculating the indicator values for 2009 for each of the 12 ESAC drug-specific quality indicators based on outpatient antibiotic use data expressed in defined daily doses per 1000 inhabitants per day (DID). For each of the indicators we grouped the 2009 indicator values into four quartiles. To evaluate changes in quality between 2004 and 2009, based on their respective indicator values, countries were also grouped according to the quartile distribution of the 2004 indicator values. Only countries able to deliver data for both years were included in this analysis.

Results: In 2009 a difference in the quality of outpatient antibiotic use between Nordic and Southern European countries was observed. Quality of outpatient antibiotic use decreased between 2004 and 2009. In particular, there were increases in the quality indicators [J01F_DID], [J01M_DID], [J01CR_%] and [J01_B/N], i.e. the use of macrolides, lincosamides and streptogramins in DID, the use of quinolones in DID, the proportional use of combinations of penicillins, including β-lactamase inhibitors and the ratio of broad- to narrow-spectrum antibiotics.

Conclusions: Quality of outpatient antibiotic use in DID decreased between 2004 and 2009. A continuous effort to improve outpatient antibiotic consumption seems to be essential to reduce outpatient antibiotic use in general and the use of broad-spectrum antibiotics in particular.

Keywords: drug consumption, quality of care, ambulatory care

Introduction

In 2007, the European Surveillance of Antimicrobial Consumption (ESAC; www.esac.ua.ac.be) project published a set of 12 valid quality indicators for outpatient antibiotic use in Europe and calculated the indicator values for 2004.[1] It was concluded that these indicators could be used to describe better outpatient antibiotic use and to assess the quality of national antibiotic prescribing patterns in Europe. In the USA total antibiotic consumption is included as a quality indicator by the National Committee for Quality Assurance,[2] and in Scotland the Scottish Government and the Scottish Antimicrobial Prescribing Group have agreed that seasonal variation of quinolone use should be ≤5%.[3]

This paper, which is one of a series of papers,[4–11] presents a detailed quality assessment of outpatient use in Europe in 2009 and an assessment of changes in quality of this use between 2004 and 2009.

Methods

A total of 35 countries were included in the ESAC project, of which 33 provided valid data. The methods used to collect data on the use of systemic antibiotics are described in an accompanying paper in this series.[4] Outpatient antibiotic use was expressed in defined daily doses (DDD) per 1000 inhabitants per day (DID). Quality of outpatient antibiotic use in 2009 was assessed for each country by calculating the indicator values for each of the 12 ESAC drug-specific quality indicators (Table 1) using outpatient antibiotic use data from 2009 available in the ESAC database. For each of the indicators, the 2009 indicator values were grouped into four quartiles according to the quartile distribution of the 2009 indicator values. Indicator values within the first quartile [i.e. values ≤percentile 25

(p25)] suggest better quality than indicator values within the second quartile (i.e. p25 < values ≤ p50), which in turn suggest better quality than indicator values within the third quartile (i.e. p50 < values ≤ p75), which suggest better quality than indicator values within the fourth quartile (i.e. values >p75) for that indicator.[1]

To evaluate changes in quality between 2004 and 2009, based on their respective indicator values, the 2009 indicator values for each country were grouped according to the quartile distribution of the 2004 indicator values. Only countries able to deliver data for both years were included in this analysis.

Results

Figure 1 shows the 2009 indicator values for 32 countries grouped into four quartiles and ranked according to decreasing quality. Countries were ranked firstly according to the number of indicator values within the fourth quartile, secondly according to the number of indicator values within the third quartile and thirdly according to the number of indicator values within the second quartile, taking into account the total number of available indicator values. Based on this ranking, the Nordic European countries (Denmark, Finland, Iceland, the Netherlands, Norway and Sweden) and the UK showed a better quality of outpatient antibiotic use compared with Belgium, France, Luxembourg and Southern European countries (Cyprus, Greece, Italy, Malta and Spain). Other countries (mostly Eastern European countries) showed moderate quality.

Twenty-eight countries were able to deliver both 2004 and 2009 data (no 2004 data for Cyprus, Lithuania, Malta and Romania). As shown in Figures 1–3, outpatient antibiotic use declined in quality between 2004 and 2009. On average, two more countries had indicator values within the fourth quartile in 2009 compared with 2004 for each of the 12 quality indicators (24 indicator values within the fourth quartile surplus in 2009 compared with 2004) at the expense of one country less with indicator values within the first quartile (12 indicator values less in 2009 compared with 2004) and one country less with indicator values within the second quartile (12 indicator values less in 2009 compared with 2004). The most significant shifts were observed for the quality indicators [J01F_DID], [J01M_DID], [J01CR_%] and [J01_B/N], i.e. the use of macrolides, lincosamides and streptogramins (MLS) in DID, the use of quinolones in DID, the proportional use of combinations of penicillins, including β-lactamase inhibitors and the ratio of broad- to narrow-spectrum antibiotics, respectively (Figures 2 and 3, and Figure S1, available as Supplementary data at *JAC* Online).

Comparing the ranking of countries between 2004 and 2009, Portugal, Slovenia, Estonia and Iceland showed a substantial quality improvement (i.e. their ranking changed by four or more positions) relative to the other countries, while in Poland, Bulgaria and Latvia the opposite was observed.

Table 1. ESAC drug-specific quality indicators for outpatient antibiotic use

Label	Description
J01_DID	consumption of antibacterials for systemic use (J01) expressed in DID
J01C_DID	consumption of penicillins (J01C) expressed in DID
J01D_DID	consumption of cephalosporins (J01D) expressed in DID
J01F_DID	consumption of macrolides, lincosamides and streptogramins (J01F) expressed in DID
J01M_DID	consumption of quinolones (J01M) expressed in DID
J01CE_%	consumption of β-lactamase-sensitive penicillins (J01CE) expressed as a percentage[a]
J01CR_%	consumption of combinations of penicillins, including β-lactamase inhibitors (J01CR) expressed as a percentage[a]
J01DD+DE_%	consumption of third- and fourth-generation cephalosporins [J01(DD+DE)] expressed as a percentage[a]
J01MA_%	consumption of fluoroquinolones (J01MA) expressed as percentage[a]
J01_B/N	ratio of the consumption of broad- {J01[CR+DC+DD+(F-FA01)]} to the consumption of narrow-spectrum penicillins, cephalosporins and macrolides [J01(CE+DB+FA01)]
J01_SV	seasonal variation of total antibiotic consumption (J01)[b]
J01M_SV	seasonal variation of quinolone consumption (J01M)[b]

[a]Percentage of total consumption of antibacterials for systemic use (J01) in DID.

[b]Overuse in the winter quarters (October–December and January–March) compared with the summer quarters (July–September and April–June) of a 1 year period starting in July and ending the next calendar year in June, expressed as a percentage: [DDD (winter quarters)/DDD (summer quarters) − 1]×100.

Discussion

Quality assessment and improvement in healthcare is a major issue in many countries.[12,13] Information on quality of healthcare is being demanded by policy makers, healthcare professionals and the general public.[14] Prescribing also has a major influence on well-being and accounts for a substantial part of healthcare expenditure.[15] If we want to improve the use of antibiotics, we have to be able to measure the quality of antibiotic use in Europe.

Benchmarking by comparisons between countries has proved to be an important stimulus to quality improvement. This applies to antibiotic consumption as well.[16] The 2009 values of the ESAC indicators of outpatient antibiotic use allow individual countries to assess their position in relation to other countries, and will hopefully trigger actions to improve antimicrobial prescribing.

The results presented here show that there is still an important north–south divide when the quality of antibiotic use is considered. For Italy, 10 of the 12 quality indicator values were within the fourth quartile, while the 2 remaining indicator values were above the median. In contrast, in Norway 9 of the 10 quality indicator values (the 2 indicators of seasonal variation could not be assessed) were within the first quartile and the remaining indicator value remained below the median. However, interpretation of ranking has to be done with caution because these 12 indicators are not independent. For example, increased use of MLS and increased proportional use of broad-spectrum penicillins will most likely result in an increased ratio of broad- to narrow-spectrum antibiotics. In addition, changes in ranking over time have to be interpreted carefully. In countries

Country	[J01_DID]	[J01C_DID]	[J01D_DID]	[J01F_DID]	[J01M_DID]	[J01CE_%]	[J01CR_%]	[J01DD+DE_%]	[J01MA_%]	[J01_B/N]	[J01_SV]	[J01M_SV]
Italy	28.66	15.18	2.78	5.33	3.61	0.01%	34.26%	7.18%	12.05%	99.28	27.34%	20.05%
Cyprus	34.44	16.01	6.45	3.98	4.13	0.34%	29.30%	1.68%	11.98%	26.93	-	-
Luxembourg	28.19	13.47	4.33	3.87	2.81	0.33%	29.93%	0.04%	9.96%	33.84	41.88%	25.28%
Belgium	27.52	15.13	1.82	2.96	2.61	0.36%	32.31%	0.00%	9.48%	43.49	33.64%	18.22%
France	29.58	16.08	2.92	4.15	2.00	0.50%	21.95%	6.41%	6.53%	42.76	-	-
Spain	19.68	12.31	1.56	1.90	2.42	0.46%	38.68%	2.76%	12.04%	56.89	25.74%	17.29%
Malta	21.59	9.08	5.50	3.89	1.66	0.13%	36.41%	0.84%	7.67%	149.49	-	-
Greece	38.64	12.89	8.68	11.54	2.63	1.88%	13.68%	0.76%	6.80%	31.68	32.55%	3.25%
Slovakia	23.78	9.56	4.12	6.09	2.03	7.75%	22.68%	2.26%	8.55%	7.39	35.08%	10.28%
Portugal	22.94	12.00	1.96	3.83	3.04	0.07%	39.24%	1.65%	13.25%	23.24	27.52%	7.35%
Hungary	15.98	7.06	1.98	3.00	1.79	4.20%	28.82%	2.41%	11.03%	12.95	57.41%	25.10%
Poland	23.59	10.68	2.89	3.88	1.25	0.63%	20.90%	0.00%	5.28%	36.28	-	-
Austria	15.93	7.09	1.80	3.93	1.33	6.23%	28.24%	4.95%	8.32%	7.39	37.46%	16.84%
Germany	14.90	4.27	2.39	2.51	1.48	5.72%	2.00%	3.42%	9.93%	3.98	46.06%	31.52%
Croatia	21.21	9.69	3.70	3.24	1.33	4.99%	23.87%	3.85%	6.27%	4.58	21.13%	-4.12%
Israel	22.42	11.82	3.96	1.90	1.44	0.36%	20.65%	0.07%	6.43%	9.58	15.43%	-6.94%
Bulgaria	18.59	8.40	2.30	3.20	1.97	1.95%	14.37%	0.90%	10.60%	6.18	-	-
Romania	10.19	4.31	2.47	1.84	1.26	1.56%	23.59%	0.97%	12.32%	6.10	-	-
Russian Fed.	12.20	4.23	0.47	1.72	2.01	0.49%	7.80%	1.97%	15.74%	7.36	18.47%	8.63%
Latvia	10.48	4.80	0.43	0.87	0.85	1.48%	12.49%	0.46%	7.74%	6.23	33.43%	19.51%
Ireland	20.76	10.66	1.33	3.79	0.94	4.09%	26.52%	0.49%	4.52%	5.44	18.91%	4.13%
Slovenia	14.42	9.51	0.42	2.33	1.08	13.51%	28.24%	0.77%	7.45%	3.47	26.00%	9.85%
Estonia	11.07	4.37	0.83	2.09	0.79	2.17%	10.83%	0.01%	7.11%	7.86	31.20%	4.39%
Czech Rep.	18.44	7.73	1.55	3.66	1.27	11.16%	21.07%	0.42%	6.90%	4.06	19.06%	9.13%
Lithuania	19.72	10.08	1.27	1.93	1.23	4.67%	8.69%	0.44%	5.73%	2.54	21.07%	4.50%
Iceland	19.35	10.41	0.30	1.15	0.55	12.14%	18.33%	0.00%	2.86%	1.67	13.46%	5.38%
Netherlands	11.39	4.48	0.04	1.46	0.89	3.42%	15.97%	0.07%	7.66%	6.42	18.04%	2.50%
Denmark	15.97	10.00	0.03	2.25	0.52	32.21%	2.57%	0.04%	3.26%	0.36	17.90%	6.60%
Finland	17.96	6.14	2.33	1.46	0.87	8.05%	6.85%	0.00%	4.87%	0.71	12.32%	6.62%
UK	17.27	8.03	0.58	2.51	0.48	4.28%	6.41%	0.02%	2.80%	0.84	17.14%	7.64%
Sweden	13.95	6.98	0.24	0.63	0.79	27.76%	1.70%	0.18%	5.65%	0.17	11.73%	1.17%
Norway	15.23	6.59	0.13	1.68	0.51	23.94%	0.02%	0.03%	3.34%	0.19	-	-

2009 quartile distribution

p0	10.19	4.23	0.03	0.63	0.48	32.21%	0.00%	0.00%	2.86%	0.17	11.73%	-6.94%
p25	15.15	6.88	0.55	1.88	0.88	6.61%	10.30%	0.04%	5.71%	3.85	18.04%	4.39%
p50	18.97	9.54	1.89	2.74	1.33	2.79%	20.99%	0.63%	7.56%	6.89	25.74%	7.64%
p75	23.10	11.86	2.90	3.87	2.01	0.48%	28.39%	2.04%	10.12%	28.11	33.43%	17.29%
p100	38.64	16.08	8.68	11.54	4.13	0.07%	39.24%	7.18%	15.74%	149.49	57.41%	31.52%

= Values within the first quartile (i.e. p0 ≤ values ≤ p25), = Values within the second quartile (i.e. p25 < values ≤ p50), = Values within the third quartile (i.e. p50 < values ≤ p75), = Values within the fourth quartile (i.e. p75 < values ≤ p100)

Figure 1. ESAC drug-specific quality indicators for outpatient antibiotic use: 2009 values for 32 countries grouped into four quartiles based on the 2009 quartile distribution. For Cyprus and Lithuania, total care data are used.

Country	[J01_DID]	[J01C_DID]	[J01D_DID]	[J01F_DID]	[J01M_DID]	[J01CE_%]	[J01CR_%]	[J01DD + DE_%]	[J01MA_%]	[J01_B/N]	[J01_SV]	[J01M_SV]
Portugal	23.78	11.18	3.22	3.66	3.04	0.37%	30.71%	2.14%	12.77%	13.48	31.80%	12.85%
Italy	24.78	12.11	3.08	4.76	2.97	0.03%	23.79%	7.38%	10.93%	55.41	25.10%	17.14%
Luxembourg	24.90	10.81	4.72	2.76	2.48	0.67%	26.17%	0.04%	9.96%	14.97	32.47%	17.75%
France	26.98	12.78	3.05	4.29	2.07	0.62%	19.15%	5.72%	7.20%	20.47	-	-
Belgium	22.71	10.51	3.14	2.33	2.46	0.63%	28.35%	0.00%	10.82%	27.73	30.94%	13.06%
Spain	18.54	10.78	1.81	2.44	2.24	0.48%	35.10%	2.58%	11.61%	42.06	29.19%	12.62%
Greece	33.01	10.35	7.15	9.74	1.87	0.76%	15.58%	0.73%	5.67%	24.34	20.36%	-31.99%
Hungary	18.18	8.36	2.20	3.09	1.65	5.98%	24.83%	2.39%	9.06%	7.38	37.86%	5.53%
Croatia	22.95	11.78	3.42	2.24	1.46	7.35%	21.72%	1.69%	6.34%	2.37	29.68%	16.08%
Austria	12.52	5.08	1.56	3.03	1.49	8.40%	24.26%	6.10%	11.91%	5.17	27.61%	16.85%
Slovakia	22.50	12.54	2.16	3.31	1.33	20.35%	15.15%	0.43%	5.91%	1.67	36.43%	4.18%
Germany	13.01	4.01	1.25	2.12	1.15	9.02%	1.46%	2.83%	8.81%	1.96	37.71%	26.39%
Slovenia	16.71	9.85	0.72	3.19	1.12	14.92%	24.05%	0.37%	6.53%	3.03	29.46%	8.81%
Israel	19.64	11.63	3.49	1.50	1.09	8.17%	17.16%	0.06%	5.54%	2.81	16.09%	-5.84%
Estonia	10.40	4.12	0.66	1.39	0.70	3.03%	6.63%	0.01%	6.69%	2.35	43.09%	13.73%
Russian Fed.	9.26	2.15	0.21	0.95	1.29	1.77%	2.71%	0.63%	13.16%	2.14	-	-
Iceland	21.44	11.07	0.44	1.67	0.65	13.63%	12.78%	0.27%	3.04%	1.01	17.79%	8.58%
Ireland	20.24	9.76	1.90	2.86	0.75	4.07%	22.96%	0.72%	3.63%	4.59	9.60%	3.30%
Poland	19.12	7.19	2.52	2.98	1.00	1.51%	3.21%	0.00%	5.24%	8.13	-	-
Czech Rep.	15.85	6.80	0.95	2.67	1.27	12.09%	16.40%	0.02%	7.99%	2.86	25.12%	2.92%
Bulgaria	16.39	7.71	1.68	1.02	1.60	5.19%	8.48%	0.92%	9.77%	1.43	-	-
Latvia	11.77	5.36	0.33	0.92	0.90	1.59%	10.09%	0.11%	7.14%	2.98	-	-
Netherlands	9.75	3.76	0.05	1.38	0.84	4.27%	14.12%	0.07%	8.37%	5.12	15.34%	1.05%
UK	14.96	6.80	0.76	2.24	0.48	4.36%	6.45%	0.05%	3.17%	0.82	16.03%	7.99%
Finland	17.20	5.09	2.13	1.88	0.83	9.09%	4.77%	0.00%	4.83%	0.75	11.98%	4.29%
Denmark	14.05	8.81	0.02	2.24	0.28	36.98%	0.44%	0.01%	2.01%	0.22	17.29%	7.96%
Norway	15.66	6.54	0.27	1.79	0.43	24.81%	0.00%	0.00%	2.76%	0.15	-	-
Sweden	14.48	6.52	0.40	0.82	0.98	26.82%	1.33%	0.13%	6.76%	0.15	9.58%	5.40%

2004 quartile distribution

p0	9.26	2.15	0.02	0.82	0.28	36.98%	0.00%	0.00%	2.01%	0.15	9.59%	-5.84%
p25	14.37	6.23	0.60	1.63	0.84	9.84%	6.03%	0.03%	5.46%	1.61	16.39%	4.21%
p50	17.69	8.59	1.74	2.28	1.21	4.77%	15.37%	0.32%	6.95%	2.92	26.37%	8.28%
p75	22.55	10.87	3.06	3.04	1.70	1.32%	23.86%	1.80%	9.81%	9.46	31.58%	13.56%
p100	33.01	12.78	7.15	9.74	3.04	0.03%	35.10%	7.38%	13.16%	55.41	43.09%	26.39%

■ = Values within the first quartile (i.e. p0 ≤ values ≤ p25), ■ = Values within the second quartile (i.e. p25 < values ≤ p50), ■ = Values within the third quartile (i.e. p50 < values ≤ p75), ■ = Values within the fourth quartile (i.e. p75 < values ≤ p100)

Figure 2. ESAC drug-specific quality indicators for outpatient antibiotic use: 2004 values for 28 countries grouped into four quartiles based on the 2004 quartile distribution.

where a better ranking suggests quality improvement, this could simply reflect a slower decrease in quality relative to the other countries.

Finally, it could be argued that use data alone cannot indicate quality without being related to clinical information.[1] That is why the ESAC group has also developed disease-specific outpatient antibiotic prescribing quality indicators, the assessment of antibiotic prescribing rates, the use of recommended antibiotics and the use of quinolones in seven main indications for antibiotic use in a very pragmatic way.[17] Evaluating quality over time

Country	[J01_DID]	[J01C_DID]	[J01D_DID]	[J01F_DID]	[J01M_DID]	[J01CE_%]	[J01CR_%]	[J01DD+DE_%]	[J01MA_%]	[J01_B/N]	[J01_SV]	[J01M_SV]
Luxembourg	28.19	13.47	4.33	3.87	2.81	0.33%	29.93%	0.04%	9.96%	33.84	41.88%	25.28%
Italy	28.66	15.18	2.78	5.33	3.61	0.01%	34.26%	7.18%	12.05%	99.28	27.34%	20.05%
France	29.58	16.08	2.92	4.15	2.00	0.50%	21.95%	6.41%	6.53%	42.76	-	-
Belgium	27.52	15.13	1.82	2.96	2.61	0.36%	32.31%	0.00%	9.48%	43.49	33.64%	18.22%
Portugal	22.94	12.00	1.96	3.83	3.04	0.07%	39.24%	1.65%	13.25%	23.24	27.52%	7.35%
Spain	19.68	12.31	1.56	1.90	2.42	0.46%	38.68%	2.76%	12.04%	56.89	25.74%	17.29%
Hungary	15.98	7.06	1.98	3.00	1.79	4.20%	28.82%	2.41%	11.03%	12.95	57.41%	25.10%
Greece	38.64	12.89	8.68	11.54	2.63	1.88%	13.68%	0.76%	6.80%	31.68	32.55%	3.25%
Slovakia	23.78	9.56	4.12	6.09	2.03	7.75%	22.68%	2.26%	8.55%	7.39	35.08%	10.28%
Austria	15.93	7.09	1.80	3.93	1.33	6.23%	28.24%	4.95%	8.32%	7.39	37.46%	16.84%
Poland	23.59	10.68	2.89	3.88	1.25	0.63%	20.90%	0.00%	5.28%	36.28	-	-
Croatia	21.21	9.69	3.70	3.24	1.33	4.99%	23.87%	3.85%	6.27%	4.58	21.13%	−4.12%
Germany	14.90	4.27	2.39	2.51	1.48	5.72%	2.00%	3.42%	9.93%	3.98	46.06%	31.52%
Israel	22.42	11.82	3.96	1.90	1.44	0.36%	20.65%	0.07%	6.43%	9.58	15.43%	−6.94%
Russian Fed.	12.20	4.23	0.47	1.72	2.01	0.49%	7.80%	1.97%	15.74%	7.36	18.47%	8.63%
Bulgaria	18.59	8.40	2.30	3.20	1.97	1.95%	14.37%	0.90%	10.60%	6.18	-	-
Ireland	20.76	10.66	1.33	3.79	0.94	4.09%	26.52%	0.49%	4.52%	5.44	18.91%	4.13%
Latvia	10.48	4.80	0.43	0.87	0.85	1.48%	12.49%	0.46%	7.74%	6.23	33.43%	19.51%
Czech Rep.	18.44	7.73	1.55	3.66	1.27	11.16%	21.07%	0.42%	6.90%	4.06	19.06%	9.13%
Slovenia	14.42	9.51	0.42	2.33	1.08	13.51%	28.24%	0.77%	7.45%	3.47	26.00%	9.85%
Netherlands	11.39	4.48	0.04	1.46	0.89	3.42%	15.97%	0.07%	7.66%	6.42	18.04%	2.50%
Estonia	11.07	4.37	0.83	2.09	0.79	2.17%	10.83%	0.01%	7.11%	7.86	31.20%	4.39%
Finland	17.96	6.14	2.33	1.46	0.87	8.05%	6.85%	0.00%	4.87%	0.71	12.32%	6.62%
Iceland	19.35	10.41	0.30	1.15	0.55	12.14%	18.33%	0.00%	2.86%	1.67	13.46%	5.38%
UK	17.27	8.03	0.58	2.51	0.48	4.28%	6.41%	0.02%	2.80%	0.84	17.14%	7.64%
Denmark	15.97	10.00	0.03	2.25	0.52	32.21%	2.57%	0.04%	3.26%	0.36	17.90%	6.60%
Norway	15.23	6.59	0.13	1.68	0.51	23.94%	0.02%	0.03%	3.34%	0.19	-	-
Sweden	13.95	6.98	0.24	0.63	0.79	27.76%	1.70%	0.18%	5.65%	0.17	11.73%	1.17%

2004 quartile distribution

p0	9.26	2.15	0.02	0.82	0.28	36.98%	0.00%	0.00%	2.01%	0.15	9.59%	−5.84%
p25	14.37	6.23	0.60	1.63	0.84	9.84%	6.03%	0.03%	5.46%	1.61	16.39%	4.21%
p50	17.69	8.59	1.74	2.28	1.21	4.77%	15.37%	0.32%	6.95%	2.92	26.37%	8.28%
p75	22.55	10.87	3.06	3.04	1.70	1.32%	23.86%	1.80%	9.81%	9.46	31.58%	13.56%
p100	33.01	12.78	7.15	9.74	3.04	0.03%	35.10%	7.38%	13.16%	55.41	43.09%	26.39%

= Values within the first quartile (i.e. p0 ≤ values ≤ p25), = Values within the second quartile (i.e. p25 < values ≤ p50), = Values within the third quartile (i.e. p50 < values ≤ p75), = Values within the fourth quartile (i.e. p75 < values ≤ p100)

Figure 3. ESAC drug-specific quality indicators for outpatient antibiotic use: 2009 values for 28 countries grouped into four quartiles based on the 2004 quartile distribution.

allows countries to position themselves and intervene if necessary.

Using the ESAC drug-specific indicators to assess quality over time revealed that increased use of MLS and quinolones, increased proportional use of combinations of penicillins, including β-lactamase inhibitors and an increased ratio of broad- to narrow-spectrum antibiotics all seem to cause the largest shifts in quality of outpatient antibiotic use. Over a period of 5 years, Poland, Bulgaria and Latvia maintained an overall intermediate quality, even though increased use of broad-spectrum antibiotics was observed there as well. Therefore, an increased antibiotic awareness in these countries also seems to be desirable.

Importantly, quality improvement was also observed, mainly because of a statistically significant reduction in seasonal variation of prescribing, for both total antibiotics and quinolones, between 1997 and 2009.[4,8] In Scotland, seasonal variation of quinolone use has been implemented already as a quality indicator as part of a strategy to reduce *Clostridium difficile* infections. NHS boards have to achieve seasonal variation $\leq$5%.[3] One year after the implementation of this strategy, most of them achieved this target.

In conclusion, the ESAC quality indicators have resulted in improved antibiotic prescribing in several European countries. However, increased use of broad-spectrum antibiotics in DID was observed between 2004 and 2009. Therefore, a continuous effort to improve outpatient antibiotic consumption seems to be essential to reduce outpatient antibiotic use in general and the use of broad-spectrum antibiotics in particular.

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Supplementary data

Figure S1 is available as Supplementary data at *JAC* Online (http://jac.oxfordjournals.org).

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