Public Health England

Voluntary surveillance of bacteraemia due to *Klebsiella* spp., *Enterobacter* spp. *Serratia* spp. and *Citrobacter* spp. in England, Wales and Northern Ireland: 2012

About Public Health England

Public Health England's mission is to protect and improve the nation's health and to address inequalities through working with national and local government, the NHS, industry and the voluntary and community sector. PHE is an operationally autonomous executive agency of the Department of Health.

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Executive summary

These analyses are based on data extracted from the Public Health England (PHE) voluntary surveillance database, LabBase2[1], on 3 September 2013 relating to diagnoses made during 2008 - 2012. The data presented here differ in some instances from data in earlier publications due to the inclusion of late reports.

Rates were calculated using 2012 mid-year resident population estimates based on the 2011 census for England, Wales, and Northern Ireland [1][2]. Geographical analyses were based on the residential location of the patient with reference to the Government Office Regions due to unavilability of population data at the time of producing this report. Future reports will include data presented by PHE centre.

This report includes analyses of the trends, patient demographic and geographical distribution as well as antimicrobial susceptibility of the causative organism identified in these bacteraemia cases.

[1] LabBase2 is the database that stores microbiology reports from NHS and other laboratories throughout England, Wales and Northern Ireland. The database is managed by PHE in Colindale, London

Key Points

- between 2011 and 2012 the total number of bacteraemia episodes reported for the four genera combined declined by 2.5% (from 10,324 to 10,066 respectively). This was largely accounted for by the decrease in *Enterobacter* spp. episodes in the same period (by 6.6%).
- the rate of bacteraemia reports due to *Klebsiella* spp. per 100,000 population was stable between 2008 and 2010 but increased by 6.3% from 10.7/100,000 in 2010 to 11.3/100,000 in 2012. Between 2008 and 2012 the rate for *Enterobacter* spp. decreased steadily (from 4.3/100,00 to 3.3/100,000); *Serratia* spp. also decreased steadily (from 1.9/100,000 to 1.4/100,000). The trend for *Citrobacter* spp. remained unchanged.
- in 2012, the majority of bacteraemic episodes were identified to species level: 98% for *Klebsiella* spp., 94% for *Enterobacter* spp., 96% for *Serratia* spp. and 92% for *Citrobacter* spp. This represented a continuing improvement in species identification over previous years.
- of all species examined, of note was *K. aerogenes* which reduced considerably from 4% of total *Klebsiella* spp. reports in 2008 (250/6,093) to <1% in 2012 (9/6,619).
- the rate was higher among infants (<1 year) and the elderly.The rate was higher among males particulary those aged ≥75 years.
- at country level, N. Ireland had the highest rate of bacteraemia due to *Klebsiella* spp. (11.79/100,000). Wales had the highest rate of bacteraemia in relation to *Enterobacter* spp. and *Serratia* spp. (3.55/100,000 and 2.15/100,000 respectively). England had the highest rate of bacteraemia due to *Citrobacter* spp. (1.24/100,000).
- in England, the North West region had the highest bacteraemia rate for *Klebsiella* spp. (13.99/100,000). London had the highest rate in relation to *Enterobacter* spp. (4.57/100,000) and *Citrobacter* spp. (1.73/100,000). North East had the highest rate for *Serratia* spp. (1.84/100,000).
- in general, the proportion of isolates resistant to cephalosporin antibiotics decreased significantly across all genera from 2008 to 2012; of note, *Enterobacter* spp. exhibited the largest reduction (from 38% to 26% for cefotaxime and from 28% to 19% for ceftazidime). Resistance to ciprofloxacin decreased significantly across all genera. Resistance to piperacillin-tazobactam decreased significantly only for *Serratia* spp. whilst a significant increase

occurred for *Klebsiella* spp. Resistance to gentamicin decreased significantly in all genera except for *Citrobacter* spp. For some of the listed antibiotics, a large decline in resistance between 2008 and 2009 followed by generally stable numbers affected the estimation of the overall trend.

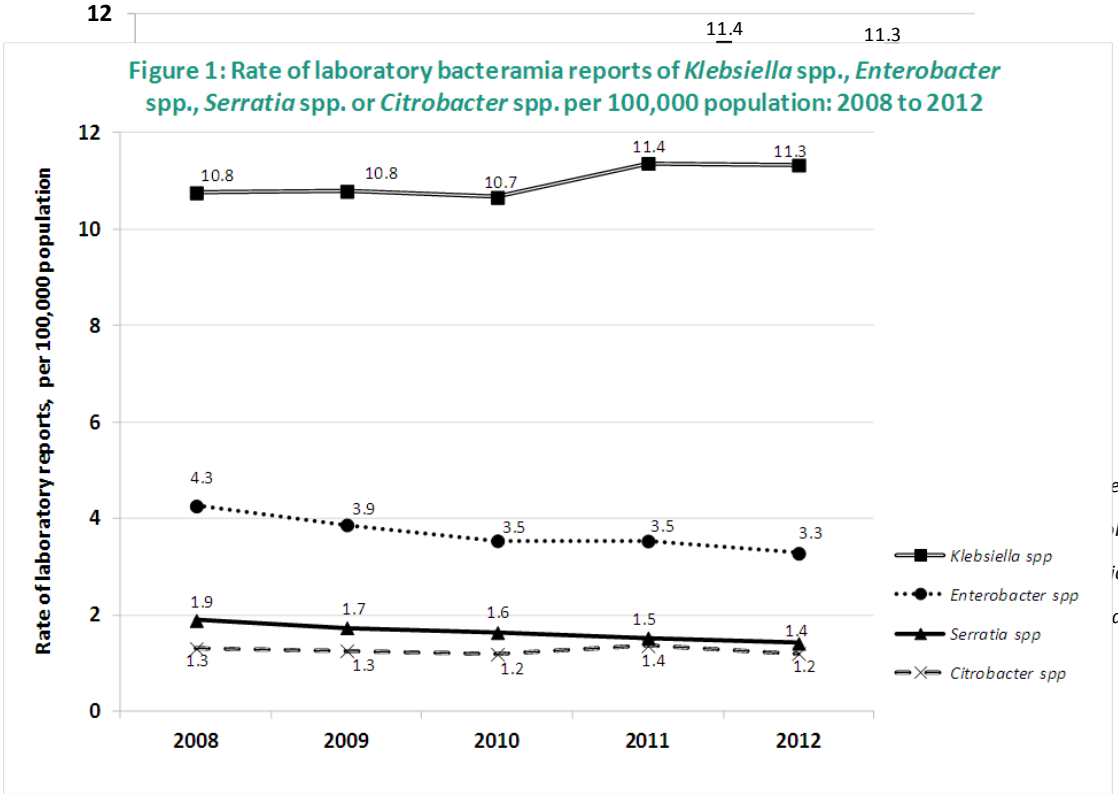
- the number of carbapenem-resistant *Klebsiella* spp. isolates did not increase further in 2012 with 37 isolates identified.
- multi-resistance to a cephalosporin (cefotaxime or ceftazidime), a fluoroquinolone (ciprofloxacin) and an aminoglycoside (gentamicin) decreased between 2008 and 2012 across all four genera.

Trends in episode numbers and rates

Overall, between 2011 and 2012, the total number of episodes for the four genera combined declined by 2.5% (from 10,324 to 10,066 respectively). This decrease was largely accounted for by a 6.6% decrease in the number of *Enterobacter* spp. episodes in the same period. The number of *Klebsiella* spp. episodes however remained elevated in 2012 with 6,594 reported (representing a marginal increase of 0.4% from 2011). Of note, the number of reports due to *Klebsiella* spp. exhibited little variation from 2008 to 2010 (around 6,000 annually). However from 2010 to 2011, a 7.5% increase in *Klebsiella* spp. episodes was observed which in turn largely accounted for the increase in total reports for the combined four genera over the same period. Reports of *Klebsiella* spp. episodes has remained elevated since 2011.

Figure 1 shows trends in the incidence of bacteraemia per 100,000 population by genus between 2008 and 2012. *Klebsiella* spp. exhibited the highest rate whilst *Citrobacter* spp had the lowest rate. An increase of 6.3% in the rate of *Klebsiella* spp. bacteraemia reports was observed between 2010 and 2012 (from 10.7/100,000 to 11.3/100,00). A consistent albeit small decrease was

Figure 1: Rate of laboratory bacteramia reports of *Klebsiella* spp., *Enterobacter* spp., *Serratia* spp. or *Citrobacter* spp. per 100,000 population: 2008 to 2012



Source: PHE. Data extracted on 3 September 2013

Table 1 gives a breakdown of the number of reports by species between 2008 and 2012. In 2012, the majority of isolates from blood were identified to species level across the four genera under study: 98% for *Klebsiella* spp., 94% for *Enterobacter* spp., 96% for *Serratia* spp. and 92% for *Citrobacter* spp. The level of species identification in 2012 represents a continuing improvement over previous years. It should be noted that the analysis for 'other named species' includes the species identifed or the option 'other named species' if selected by the reporting laboraory.

In 2012, the predominant *Klebsiella* species causing bacteraemia was *K. pneumoniae* (77%) followed by *K. oxytoca* (20%). *K. aerogenes* was less frequent accounting for <5% of total episodes but it reduced considerably over the five year period from 4% of total *Klebsiella* spp. reports in 2008 (250/6,093) to <1% in 2012 (9/6,619). The other named species reported were: *K. ornithinolytica (Raoultella ornithinolytica), K. ozaenae* and *K. rhinoscleromatis* whose numbers were very small but broadly unchanged in the five year period.

For *Enterobacter* spp., the predominant species in 2012 was *E. cloacae* (72%) followed by *E. aerogenes* (19%). *E. cloacae* decreased slowly in terms of the number of episodes and as a proportion of total *Enterobacter* spp. episodes reported over the five year period. A marginal year on year increase was observed from 2009 to 2012 in relation to *E. aerogenes.* The other named species reported were *E. agglomerans (Pantoea agglomerans), E. amingenus, E. gergoviae and E. intermedium* whose numbers were very small and broadly unchanged in the five year period.

The predominant *Serratia* spp. species in 2012 was *S. marcescens* (83%) followed by *S. liquefaciens* (10%). The other named species reported were *S. ficaria*, *S. fonticola*, *S. odorifera*, *S. plymuthica*, *S. proteamaculans* and *S. rubidaea* involving very small numbers with an unchanging trend.

For *Citrobacter* spp. the predominant species was *C. koseri* (*diversus*) (47%) followed by *C. freundii* (38%) although the reverse was observed for these two in 2008. The other named species reported was *C. amalonaticus* with extremely small numbers but unchanged in the five year period.

A further 174 reports were attributed to six other genera (*Pantoea spp*., *Hafnia spp.*, *Kluyvera spp.*, *Edwardsiella spp.*, *Leclercia* spp*.,* and *Rahnella* spp.) that are closely related to the four main genera. For this group of organisms, the number of reports decreased by 20% from 2011 to 2012.

Table 1. Reports of bacteraemia due to *Klebsiella* spp., *Enterobacter* spp., *Serratia* spp., *Citrobacter* spp. and related genera (England, Wales and Northern Ireland): 2008 to 2012*

	2008		2009		2010		2011		2012	
	No.	%	No.	%	No.	%	No.	%	No.	%
***Klebsiella* spp.**	**6,093**	100%	**6,155**	100%	**6,133**	100%	**6,594**	100%	**6,619**	100%
Klebsiella pneumoniae	4,162	68%	4,317	70%	4,524	74%	4,969	75%	5,105	77%
Klebsiella oxytoca	1,311	22%	1,336	22%	1,320	22%	1,313	20%	1,308	20%
Klebsiella aerogenes	250	4%	198	3%	51	1%	22	0%	9	0%
Klebsiella, other named species	68	1%	41	1%	40	1%	56	1%	72	1%
Klebsiella, species not recorded	302	5%	263	4%	198	3%	234	4%	125	2%
***Enterobacter* spp.**	**2,414**	100%	**2,208**	100%	**2,037**	100%	**2,052**	100%	**1,917**	100%
Enterobacter cloacae	1,833	76%	1,684	76%	1,520	75%	1,528	74%	1,372	72%
Enterobacter aerogenes	357	15%	315	14%	334	16%	339	17%	361	19%
Enterobacter sakazakii	30	1%	27	1%	28	1%	21	1%	19	1%
Enterobacter, other named species	58	2%	72	3%	68	3%	62	3%	52	3%
Enterobacter, species not recorded	136	6%	110	5%	87	4%	102	5%	113	6%
***Serratia* spp.**	**1,071**	100%	**992**	100%	**943**	100%	**887**	**100%**	**827**	100%
Serratia marcescens	815	76%	776	78%	775	82%	704	79%	683	83%
Serratia liquefaciens	123	11%	123	12%	102	11%	107	12%	81	10%
Serratia, other named species	29	3%	27	3%	17	2%	28	3%	31	4%
Serratia, species not recorded	104	10%	66	7%	49	5%	48	5%	32	4%
***Citrobacter* spp.**	**740**	100%	**719**	100%	**685**	**100%**	**791**	100%	**703**	100%
Citrobacter freundii	326	44%	282	39%	254	37%	285	36%	267	38%
Citrobacter koseri (C. diversus)	276	37%	317	44%	320	47%	384	49%	328	47%
Citrobacter, other named species	49	7%	51	7%	49	7%	64	8%	53	8%
Citrobacter, species not recorded	89	12%	69	10%	62	9%	58	7%	55	8%
Four main genera combined	**10,318**		**10,074**		**9,798**		**10,324**		**10,066**	
***Edwardsiella* spp.**	**2**		**0**		**2**		**3**		**2**	
***Hafnia* spp.**	**44**		**32**		**38**		**28**		**37**	
***Kluyvera* spp.**	**18**		**20**		**21**		**12**		**26**	
***Leclercia* spp.**	**6**		**5**		**12**		**5**		**4**	
***Pantoea* spp.**	**99**		**98**		**67**		**92**		**104**	
***Rahnella* spp.**	**2**		**4**		**4**		**5**		**1**	
Other genera combined	**171**		**159**		**144**		**145**		**174**	

Source: PHE. Data extracted on 3 September 2013

Age and sex distribution

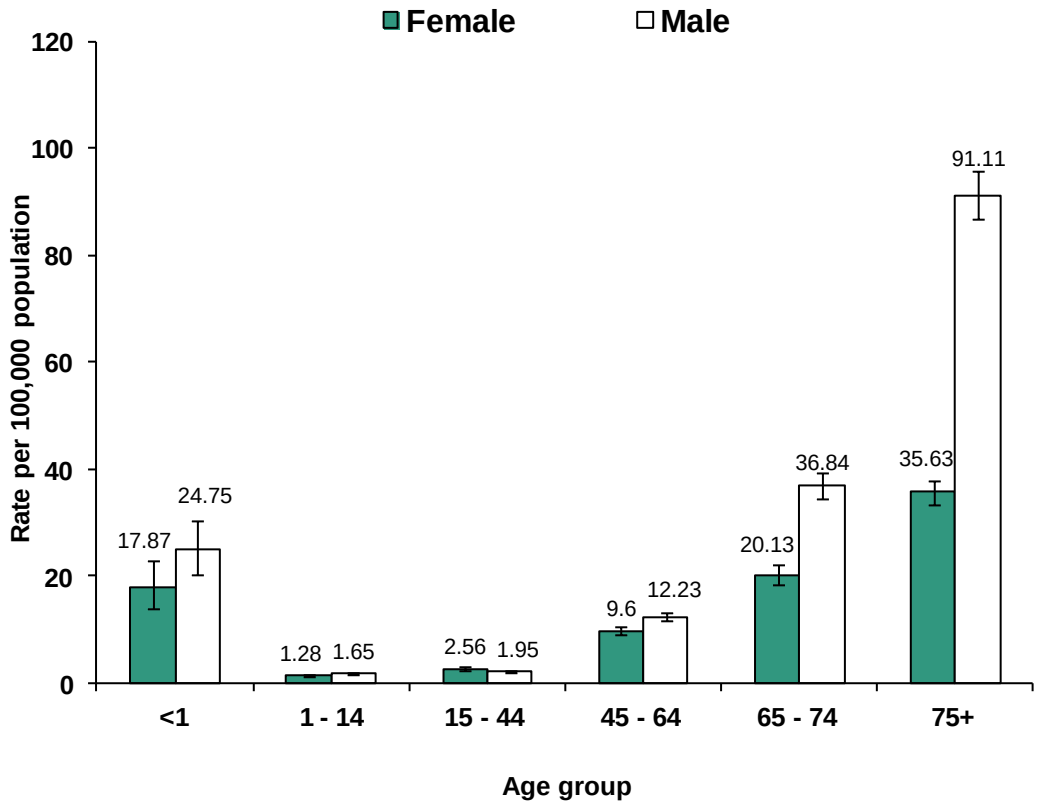
Figures 2 to 5 show the age and sex-specific rate of bacteraemia reports in England, Wales and Northern Ireland in 2012 per 100,000 population for each genus under study. The rate was generally higher among infants (under one year) and the elderly although the rate in the infant group was based on a relativley small number of reported episodes: 162 for *Klebsiella* spp.;105 for *Enterobacter* spp., 27 for *Serratia* spp. and 15 for *Citrobacter* spp.

The rate was higher among males which was reflected across all age groups except among patients aged 15-44 years where the rate was marginally higher in females; the other exception was among the infant group affected by *Serratia* spp or *Citrobacter* spp. where the rate was higher among females.

The highest rate was found among male patients aged 75 years or more across all genera. To illustrate, for *Klebsiella* spp. (Fig 2) the rate among male patients aged 75 years and over was 91.11/100,000 and was more than double the rate for females in the same age group (35.63/100,000); the male to female rate ratio was 2.56 in this group and was higher than the other age groups within *Klebsiella* spp. A similar result was observed for *Enterobacter* spp. and *Citrobacter* spp. For *Serratia* spp. the rate among males aged 75 years and over was also higher than those for females in the same age group but the patient sex rate ratio (male to female) for this group was found to be similar only to patients aged 65-74 years.

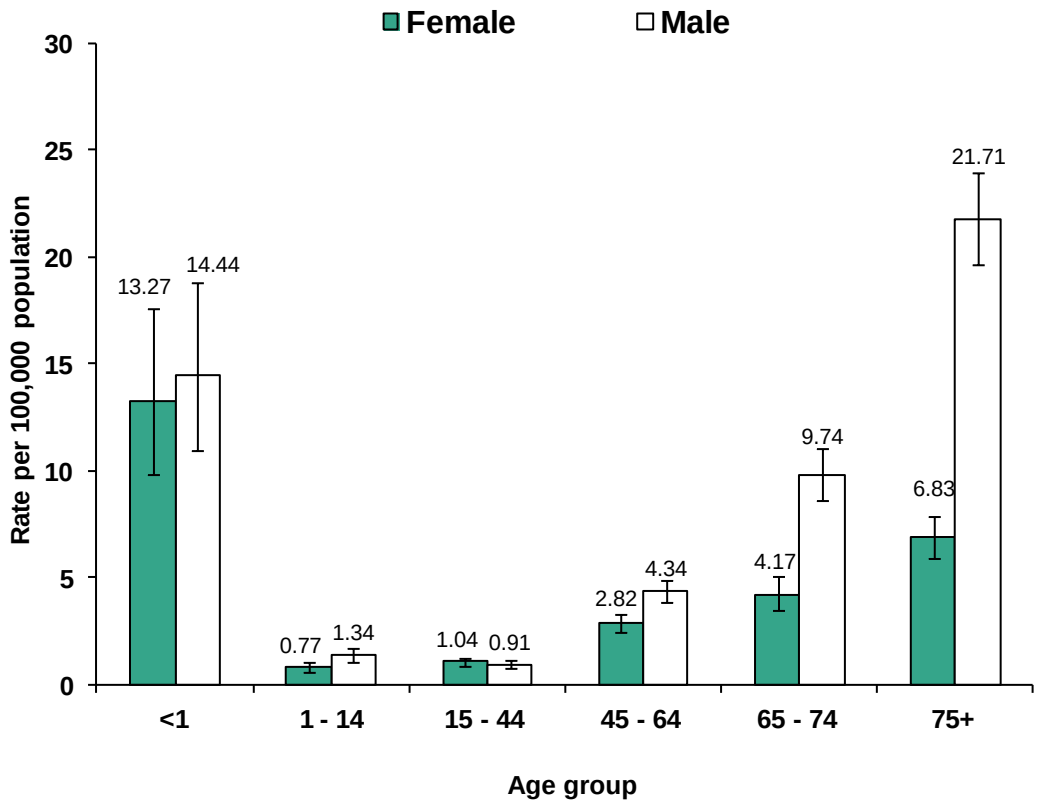
The rate among male infants decreased each year between 2010 and 2012 from 27.30 to 24.75 per 100,000 population. The rate also decreased among female infants over this time from 23.99 to 17.87 per 100,000 population for this organism[3]. Of the remainig three genera, an appreciable change was observed only among male infants with *Enterbacter* spp. bacteraemia reducing from 22.79/100,000 in 2010 to 14.44/100,000 in 2012. The rate was found to be similar over this time period among the infant group affected by the other three organisms.

Figure 2. Age and sex-specific rates of *Klebsiella* spp. bacteraemia reports, England, Wales and Northern Ireland per 100,000 population: 2012



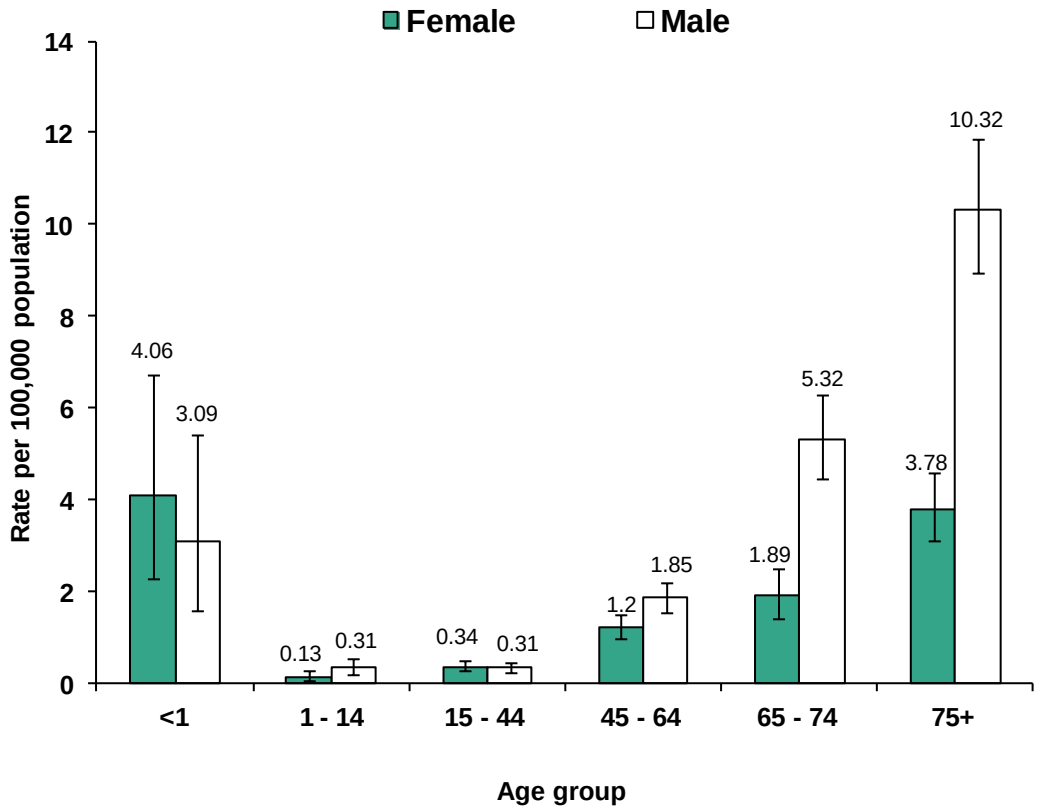
Source: PHE. Data extracted on 3 September 2013

Figure 3. Age and sex-specific rates of *Enterobacter* spp. bacteraemia reports, England, Wales and Northern Ireland per 100,000 population: 2012



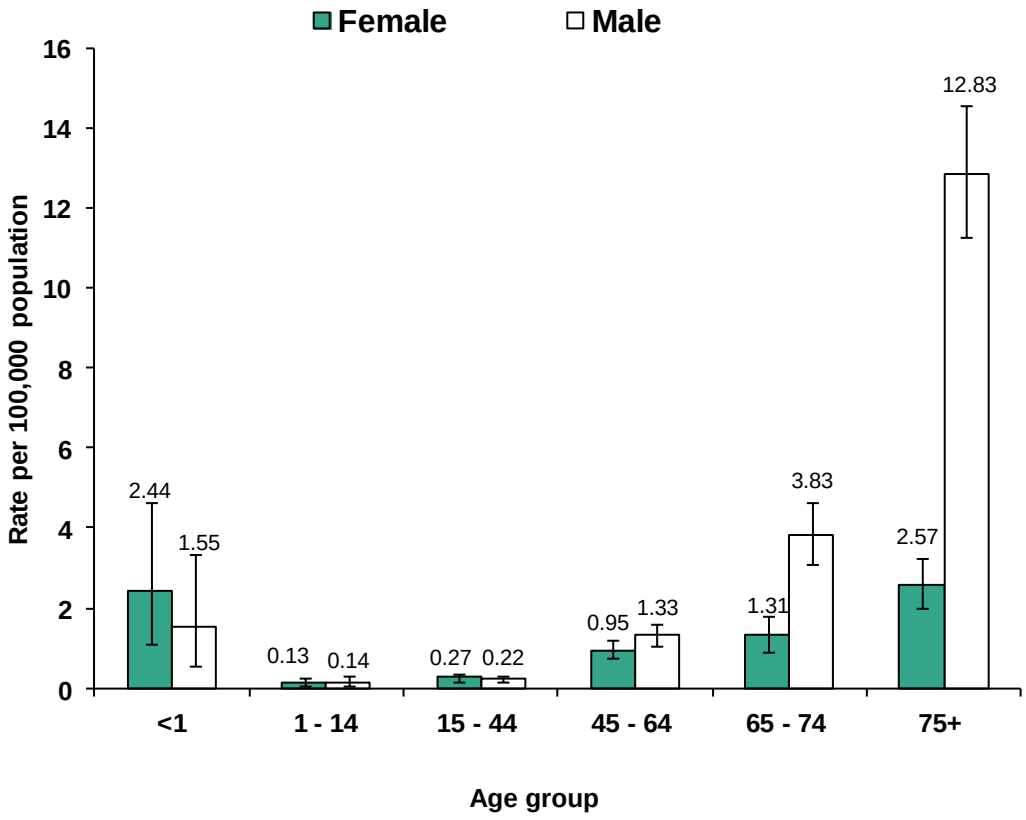
Source: PHE. Data extracted on 3 September 2013

Figure 4. Age and sex-specific rates of *Serratia* spp. bacteraemia reports, England, Wales and Northern Ireland per 100,000 population: 2012



Source: PHE. Data extracted on 3 September 2013

Figure 5. Age and sex-specific rates of *Citrobacter* spp. bacteraemia reports, England, Wales and Northern Ireland per 100,000 population: 2012



Source: PHE. Data extracted on 3 September 2013

Geographic distribution

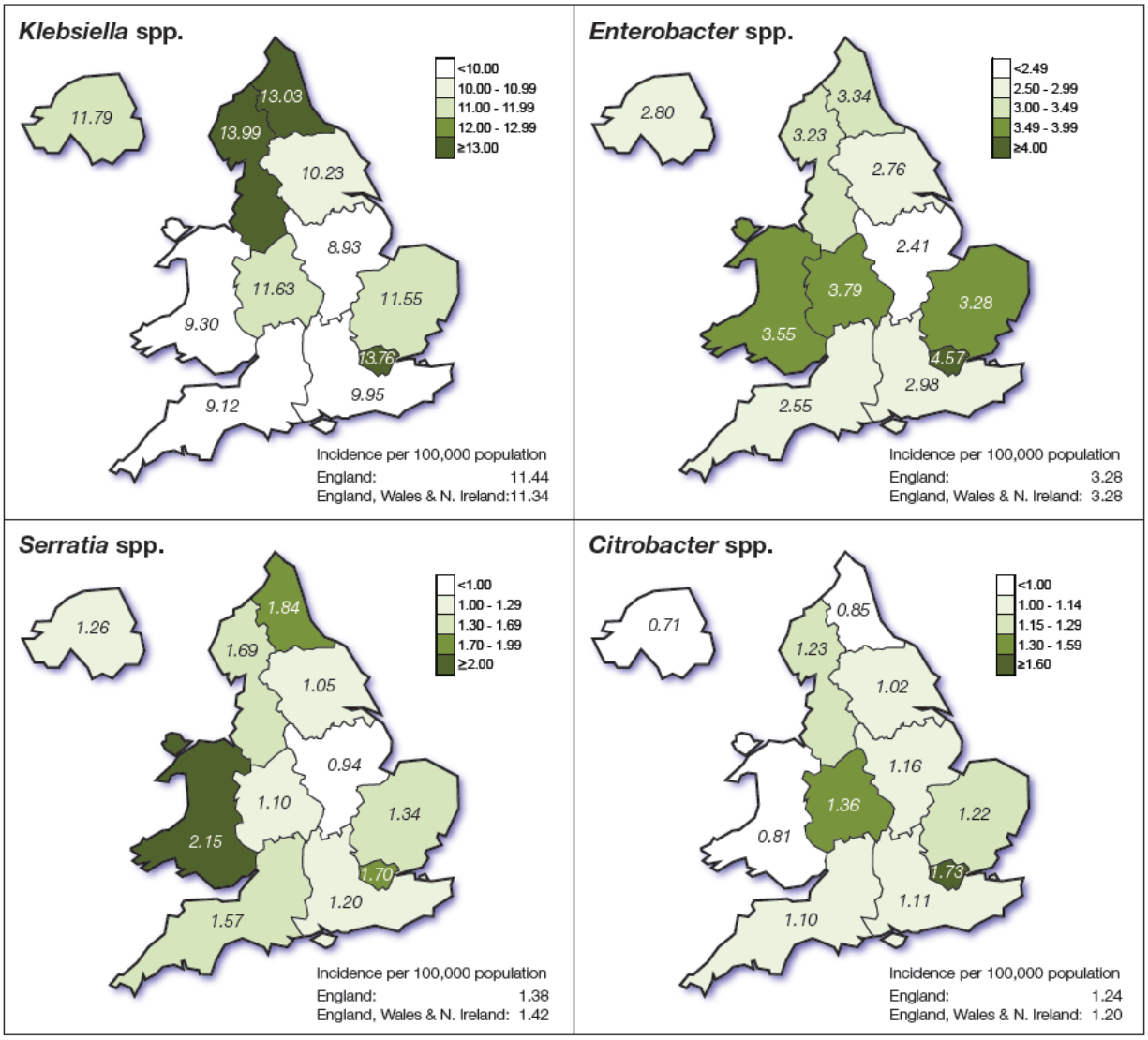
Figure 5 shows the bacteraemia rate per 100,000 population for each genus at country-level and at regional level for England. Overall, the bacteraemia rate for England, Wales and Northern Ireland combined was 11.34/100,000 for *Klebsiella* spp.; 3.28/100,000 for *Enterobacter* spp.; 1.42/100,000 for *Serratia* spp. and 1.20/100,000 for *Citrobacter* spp.

At country level, Northern Ireland had the highest rate of bacteraemia reports due to *Klebsiella* spp. at 11.79/100,000 population; for *Enterobacter* spp. and for *Serratia* spp. Wales had the highest rate (3.55/100,000 and 2.15/1000,000 respectively); for *Citrobacter* spp., England exhibited the highest rate (1.24/100,000).

Within England, regional variation in the incidence rate of bacteraemia reports was evident in each of the four genera. Of all regions, North West, North East and London emerged as having the highest rates for either one or several of the four genera under study. In 2012, North West region had the highest incidence rate of *Klebsiella* spp. reports at 13.99/100,000. London region was found to have the highest incidence rates of reports of *Enterobacter* spp. (4.57/100,000) and *Citrobacter* spp. (1.73/100,000). North East region had the highest incidence of *Serratia* spp at 1.84/100,000.

The regional variation may be explained by differences in completeness of reporting between various regions. Other factors include case-mix, i.e. variation in the distribution of specialist care units between regions.

Figure 5. Geographic distribution of the rate of bacteraemia reports due to *Klebsiella* spp., *Enterobacter* spp., *Serratia* spp. or *Citrobacter* spp., per 100,000 population, England, Wales and Northern Ireland: 2012



Source: PHE. Data extracted on 3 September 2013

Antimicrobial susceptibility data

Tables 2 to 5 present antibiotic susceptibility data from 2008 to 2012 for each of the four genera. The susceptibility data covers five classes of antibiotics: third-generation cephalosporins (cefotaxime or ceftazidime), the carbapenems (impenem/meropenem), a fluoroquinolone (ciprofloxacin), a penicillin/beta-lactamase inhibitor combination (piperacillin/tazobactam) and an aminoglycoside (gentamicin). Table 6 presents multi-resistance data for each of the four genera based on resistance to any combination of cephalosporins, ciprofloxacin and gentamicin.

Cephalosporins are the antibiotic group to which *Enterobacter* spp., *Serratia* spp. and *Citrobacter* spp. show the greatest level of resistance compared with the other antibiotics examined. *Klebsiella* spp. isolates exhibited the lowest susceptibility by comparison.

Among *Klebsiella* spp. isolates, resistance to cefotaxime and ceftazidime was 10% and 11% respectively in 2008. The trend analysis did not show evidence of a significant decrease for cefotaxime while a significant decrease was found for ceftazidime (Table 2). However for ceftazidime the large decrease from 2008 to 2009 followed by small upward increases affected the estimation of the overall trend. Among *Klebsiella* spp. the most common mechanism of resistance to cefotaxime and ceftazidime is ESBL production.

Almost 40% of *Enterobacter* spp. isolates exhibited resistance to cephalosporins in 2008 followed by year on year decreases and by 2012 the level of resistance reached 26% for cefotaxime and 29% for ceftazidime (Table 3). The steady decrease in resistance to these two antibiotics was found to be statistically significant and the underlying data showed that the biggest decrease occurred from 2008 to 2009. Among *Enterobacter* spp., resistance to cefotaxime and ceftazidime occurs through a different mechanism and commonly reflects de-repressed AmpC activity.

The five year data indicated that the proportion of *Serratia* spp*.* isolates that were resistant to cephalosporins reduced steadily; for cefotaxime this reduced from 28% in 2008 to 19% in 2012 while for ceftazidime, the level of resistance reduced from 22% in 2008 to 14% in 2012 (Table 4). The trend analysis indicated that these reductions were statistically significant although the overall trend was largely affected by the steady and steep decline observed from 2010 and 2012 for each cephalasporin drug. Among *Citrobacter* spp. isolates, the level of resistance to cefotaxime and ceftazidime also reduced (Table 5). The decreasing trend was found to be statistically significant but the number of isolates involved throughout the five year period was small. It should be noted that although some isolates of *Citrobacter* spp. are not identified to species level (8% in 2012), it is known that cephalosporin resistance in *C. freundii* is mediated by mechanisms similar to those found amongst *Enterobacter* (AmpC beta-lactamases and ESBLs), while in *C. koseri* cephalosporin resistance is mediated by the bla_{CKO} gene encoding chromosomal class A beta-lactamase[4].

A significantly declining trend in resistance to ciprofloxacin was found for each of the four genera between 2008 and 2012 (Tables 2-5). However these results were affected by a high number of resistant isolates in 2008 and the decline was generally less pronounced from 2009 onwards. In relation to piperacillin/tazobactam, the proportion of laboratory reports indicating resistance to this antibiotic decreased significantly only for *Serratia* spp.; for *Klebsiella* spp. a significant increase was observed and for the remaining two genera no trend was detected.

Overall, a significant reduction in resistance to gentamicin occurred for *Klebsiella spp.*, *Enterobacter* spp. *and Serratia* spp. However the estimation of the overall trend in relation to *Klebsiella spp.* and *Enterobacter* spp. was affected by a big reduction in resistant episodes between 2008 and 2009 with numbers stabilising afterwards. For *Serratia* spp, although steady decreases occurred the underlying number of isolates resistant to gentamicin was very

small throughout the five year period. *Citrobacter* spp. also comprised small numbers of isolates resistant to gentamicin throughout the study period but no trend was detected due to fluctuations in data.

Resistance to the carbapenems was uncommon in the five year period with reports at 1% or less in each of the four genera (Table 3). Despite the small underlying numbers, a year on year increase was observed for the first time among *Klebsiella* spp. isolates in the period from 2009 to 2011 which was found to be significant[5]. This increase was worrying given that this class of antibiotic is a powerful last-line treatment for serious infections and the increase was in the context of the recent emergence of resistance to this antibiotic reported internationally[6][7]. However the data for 2012 indicated that no further increase was observed in England, Wales and Northern Ireland (*n*=37 as in 2011) with the majority (70%) reported by laboratories from the North West and London regions. A significantly increasing trend was found between 2009 and 2012. Despite the small numbers involved, the trend in carbapenem-resistance amongst these *Klebsiella* spp. isolates still warrants close vigilance over the coming year.

Multi-resistance involving a combination of the cephalosporins (cefotaxime or ceftazidime), fluroquinolone (ciprofloxacin) and aminoglycoside (gentamicin) antibiotic classes is presented in Table 6 by genus. The data are based on episodes where testing on all thee antibiotic classes was reported (75% of isolates with susceptibility data on *Klebsiella* spp., *Enterobacter* spp., *Serratia* spp. and *Citrobacter* spp.). Of all genera, *Klebsiella spp.* exhibited the highest proportion of episodes that were resistant to all three antibiotic classes compared to other genera per year of analysis even with reductions over time i.e. 5.2% in 2008 and 3.3% in 2012 (Table 6). The data indicated that multi-resistance (all three antibiotic classes) declined between 2008 and 2012 across all genera in general. However a much smaller number of isolates resistant to all three classes were involved for *Citrobacter* spp. and *Serratia* spp.; these trends would have been subject to random fluctuations. A multi-resistance analysis that included cephalosporins (cefotaxime or ceftazidime),

a fluoroquinolone (ciprofloxacin) and a wider range of aminoglycosides (gentamicin, amikacin or tobramycin) showed very similar results in terms of the numbers and trends (data not shown).

For advice on treatment of antibiotic resistant infections due to these organisms or for reference services including species identification and confirmation of sensitivity testing results, laboratories should contact the PHE Antimicrobial Resistance and Healthcare Infections Reference Unit (AMRHAI) in London[8].

Table 2. Antibiotic susceptibility for *Klebsiella* spp. bacteraemia reports, England, Wales and Northern Ireland: 2008-2012

	2008		2009		2010		2011		2012	
	No. tested	% resistant	No. tested	% resistant	No. tested	% resistant	No. tested	% resistant	No. tested	% resistant
Piperacillin/ Tazobactam	4,529	11%	4,482	10%	4,635	11%	5,217	12%	5,432	13%
Imipenem/ Meropenem*†	4,458	<1%	4,420	<1%	4,407	<1%	4,851	<1%	4,977	<1%
Cefotaxime	2,980	10%	3,130	8%	3,061	9%	3,393	9%	3,487	10%
Ceftazidime	4,124	11%	4,007	9%	4,195	9%	4,618	9%	4,653	10%
Ciprofloxacin	4,883	11%	4,741	9%	4,897	8%	5,374	8%	5,528	8%
Gentamicin	5,329	7%	5,195	6%	5,276	6%	5,859	6%	5,936	6%
Total *Klebsiella* spp. reports	**6,093**		**6,155**		**6,133**		**6,594**		**6,619**	

*0.5% in 2008; 0.3% in 2009; 0.4% in 2010; 0.8% in 2011; 0.7% in 2012

† Ertapenem not included due to the small number of test results reported

Source: PHE. Data extracted on 3 September 2013

Table 3. Antibiotic susceptibility for *Enterobacter* spp. bacteraemia reports, England, Wales and Northern Ireland: 2008-2012

	2008		2009		2010		2011		2012	
	No. tested	% resistant	No. tested	% resistant	No. tested	% resistant	No. tested	% resistant	No. tested	% resistant
Piperacillin/ Tazobactam	1,784	18%	1,554	17%	1,484	18%	1,582	16%	1,499	20%
Imipenem/ Meropenem*†	1,909	<1%	1,622	<1%	1,524	<1%	1,561	<1%	1,486	<1%
Cefotaxime	1,195	38%	1,081	35%	993	33%	1,012	29%	999	26%
Ceftazidime	1,612	36%	1,376	32%	1,370	32%	1,391	30%	1,317	29%
Ciprofloxacin	1,987	8%	1,693	6%	1,638	5%	1,683	5%	1,585	5%
Gentamicin	2,139	7%	1,844	7%	1,723	5%	1,803	6%	1,708	6%
Total *Enterobacter* spp. reports	**2,414**		**2,208**		**2,037**		**2,052**		**1,917**	

*0.7% in 2008; 0.4% in 2009; 0.8% in 2010; 0.8% in 2011; 0.8% in 2012

† Ertapenem not included due to the small number of test results reported

Source: PHE. Data extracted on 3 September 2013

Table 4. Antibiotic susceptibility for *Serratia* spp. bacteraemia reports, England, Wales and Northern Ireland: 2008-2012

	2008		2009		2010		2011		2012	
	No. tested	% resistant	No. tested	% resistant	No. tested	% resistant	No. tested	% resistant	No. tested	% resistant
Piperacillin/ Tazobactam	764	16%	712	12%	712	15%	707	10%	657	8%
Imipenem/ Meropenem*†	821	<1%	780	<1%	735	<1%	701	<1%	675	<1%
Cefotaxime	537	28%	541	30%	497	29%	458	21%	454	19%
Ceftazidime	678	22%	647	20%	681	21%	643	16%	620	14%
Ciprofloxacin	864	16%	800	12%	794	12%	756	11%	709	9%
Gentamicin	917	3%	855	3%	838	2%	824	1%	762	1%
Total *Serratia* spp. reports	**1,071**		**992**		**943**		**887**		**827**	

*0.6% in 2008; 0.1% in 2009; 0.5% in 2010; 0.4% in 2011; 0.4% in 2012

† Ertapenem not included due to the small number of test results reported

Source: PHE. Data extracted on 3 September 2013

Table 5. Antibiotic susceptibility for *Citrobacter* spp. bacteraemia reports, England, Wales and Northern Ireland: 2008-2012

	2008		2009		2010		2011		2012	
	No. tested	% resistant	No. tested	% resistant	No. tested	% resistant	No. tested	% resistant	No. tested	% resistant
Piperacillin/ Tazobactam	496	7%	501	6%	504	7%	620	7%	562	9%
Imipenem/ Meropenem*†	514	<1%	505	<1%	490	0.0%	582	0.0%	527	0.0%
Cefotaxime	335	17%	322	18%	320	14%	375	13%	364	12%
Ceftazidime	473	19%	446	15%	467	13%	525	12%	502	13%
Ciprofloxacin	577	5%	545	3%	540	4%	645	3%	578	2%
Gentamicin	629	4%	607	2%	575	4%	686	3%	611	5%
Total *Citrobacter* spp. reports	**740**		**719**		**685**		**791**		**703**	

*0.4% in 2008; 0.2% in 2009; 0.0% in 2010 2011 and 2012 due to 0 isolates in these years

† Ertapenem not included due to the small number of test results reported

Source: PHE. Data extracted on 3 September 2013

Table 6. Multiple antibiotic resistance among bacteraemia reports due to *Klebsiella* spp., *Entrerobacter* spp. *Serratia* spp. and *Citrobacter* spp., England, Wales and Northern Ireland: 2008-2012

Genus	Year	Total no. of isolates tested for all three antibiotics	Combined resistance: 3rd-generation cephalosporins/ciprofloxacin/gentamicin	
			No.	%
***Klebsiella* spp.**	2008	4,131	216	5.2%
	2009	4,025	149	3.7%
	2010	4,099	154	3.8%
	2011	4,644	171	3.7%
	2012	4,809	161	3.3%
***Enterobacter* spp.**	2008	1,697	65	3.8%
	2009	1,449	41	2.8%
	2010	1,370	24	1.8%
	2011	1,409	28	2.0%
	2012	1,365	32	2.3%
***Serratia* spp.**	2008	731	4	0.5%
	2009	694	3	0.4%
	2010	685	2	0.3%
	2011	645	0	0.0%
	2012	685	0	0.0%
***Citrobacter* spp.**	2008	471	9	1.9%
	2009	446	3	0.7%
	2010	450	3	0.7%
	2011	537	3	0.6%
	2012	517	2	0.4%

Source: PHE. Data extracted on 3 September 2013

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