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Laboratory surveillance of *Klebsiella* spp. bacteraemia in England, Wales and Northern Ireland: 2018

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These analyses are based on data relating to diagnoses of bloodstream infections caused by *Klebsiella* spp. between 2009 and 2018 in England, Wales and Northern Ireland. The data were extracted on 25 September 2019 from Public Health England's (PHE) voluntary surveillance database, the Second Generation Surveillance System (SGSS). Data for Wales and Northern Ireland were extracted separately (DataStore and CoSurv systems, on 30 April 2019). *Klebsiella* spp. became mandatory for reporting in England as of April 1st 2017. This is the first HPR in which data from the mandatory surveillance scheme will also be presented.

Rates of laboratory reported bacteraemia were calculated using mid-year resident population estimates for the respective year and geography [1]. Geographical analyses were based on the patient's residential postcode. Where this information was unknown, the postcode of the patient's General Practitioner was used. Failing that, the postcode of the reporting laboratory was used. Cases in England were further assigned to one of nine local PHE Centres (PHECs), formed from the administrative local authority boundaries [2].

The following report summarises trends and geographical distribution of *Klebsiella* spp., bacteraemia. Single-agent antimicrobial susceptibility trends are reported for England and Northern Ireland, based on SGSS AMR and CoSurv data, respectively. Multi-drug resistance trends are reported for England only. A web appendix is available featuring additional findings including data submitted to SGSS from laboratories in England.

Data presented here for earlier years may differ from those in previous publications due to the inclusion of late reports. Publications from 2017 onwards, reflect the reclassification of *Enterobacter aerogenes* as part of the *Klebsiella* genus [3].

Key points

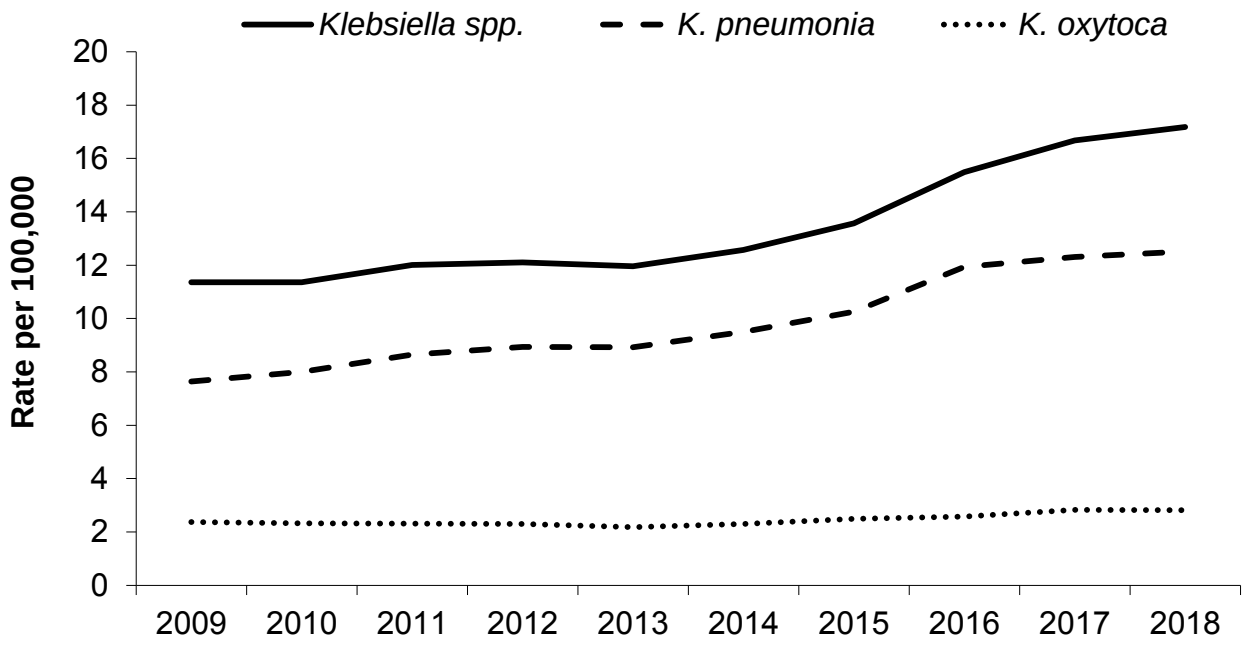
- in 2018, the rate of *Klebsiella* spp. bacteraemia for England, Wales and Northern Ireland combined was 17.2 per 100, 000 population, a 3% increase from 2017
- in 2018, rates of *Klebsiella* spp. bacteraemia per 100, 000 residents by country were respectively; 17.0 for England, 20.0 for Wales and 17.4 per 100,000 for Northern Ireland
- England and Wales continued to show slight increases from reported 2017 rates (3% and 4%, respectively), while Northern Ireland showed a slight decrease (3%)
- in England rates varied across the 9 PHECs; the highest reported in 2018 was in the North East (21.6 per 100,000), the lowest in the North West (15.1 per 100, 000)
- *K. pneumonia* and *K. oxytoca* remain the 2 most prevalent species (73% and 16%, respectively); and the number of reports of the *K. variicola* species continued to increase from 2017 (2% in 2017 to 4% in 2018)
- rates of *Klebsiella* spp. bacteraemia remain higher among the very young (less than 1 year of age) and older age groups (age 65 and older)
- rates are higher for males than females in the <1 and over 45 age groups
- single-agent antimicrobial resistance of tested *Klebsiella* spp. isolates was highest in 2018 for amoxycillin-clavulanate (31%), piperacillin/tazobactam (14%), and ceftazidime (13%)
- resistance to third-generation cephalosporins (ceftazidime and cefotaxime) has been slightly increasing since 2015 for *Klebsiella* spp. isolates (ceftazidime: 9% to 13%; cefotaxime: 9% to 12%).
- resistance to carbapenems remains low (≤2%) for *Klebsiella* spp. and the two most prominent species
- multi-drug resistance to all four antibiotics (3rd generation cephalosporins, ciprofloxacin, gentamicin and meropenem) remains relatively uncommon in *K. pneumonia* and *K. oxytoca* isolates (<1%)
- ascertainment between English mandatory and voluntary surveillance was at 92% in 2018

Trends

Between 2009 and 2018, incidence of *Klebsiella* spp. bacteraemia (Figure 1) remained relatively stable until 2013, after which a gradual annual increase has been observed. In 2018, the combined rate for England, Wales and Northern Ireland was 17.2 per 100,000 population (n = 10,480). This represents a 3% increase from the previous year, when the combined rate was 16.7 per 100,000.

As the most predominant species, trends for *K. pneumonia* mimic that of the overall genus however, annual increases since 2016 have been smaller. Between 2017 and 2018, the *K. pneumonia* bacteraemia rate remained relatively stable from 12.3 to 12.5 per 100,000. *K. oxytoca* bacteraemia rates are low, accounting for between 2-3 bacteraemia infections for every 100,000 residents. This has been the case since 2009, and in 2018 the rate remained stable from the previous year at 2.8 per 100,000.

Figure 1. *Klebsiella* spp. bacteraemia rate per 100,000 population (England, Wales and Northern Ireland): 2009 to 2018



Geographic distribution

In 2018, the rate of reported *Klebsiella* spp. bacteraemia by country was 17.0 per 100,000 population for England, 17.4 per 100,000 population for Northern Ireland and 20.0 per 100,000 population for Wales (Table 1). Rates for England and Wales continued to increase from 2017 (3% and 4%, respectively) however, this percent change was smaller than that reported in the previous year (7% and 10%, respectively). After a noticeable increase from 2016 to 2017, rates for Northern Ireland decreased slightly in 2018 (3%).

It is important to note differences in the way data are collected between the three countries. In England and Northern Ireland, microbiology laboratories electronically report clinically significant isolates to SGSS or CoSurv, respectively. In Wales, data are collected by extraction from a single laboratory information system used by all the microbiology laboratories. The system extracts all positive blood cultures, including those not thought to be clinically significant.

Within England, there was variation among the nine PHECs (Figure 2). The North East had the highest reported *Klebsiella* spp. bacteraemia rate in 2018 (21.6 per 100,000), while the North West had the lowest (15.1 per 100,000). The North East has reported the highest regional bacteraemia rates since 2015. Rates in Yorkshire and Humber and South West saw the greatest increase from 2017 (13.8 to 17.0/100,000 and 16.4 to 19.5/100,0000, respectively).

Other factors may account for the variation observed between regions. These include completeness of reporting, local outbreaks, as well as different resident populations and distribution of specialist care units.

Figure 2. Geographical distribution of *Klebsiella* spp. bacteraemia rates per 100,000 population (England, Wales and Northern Ireland): 2018

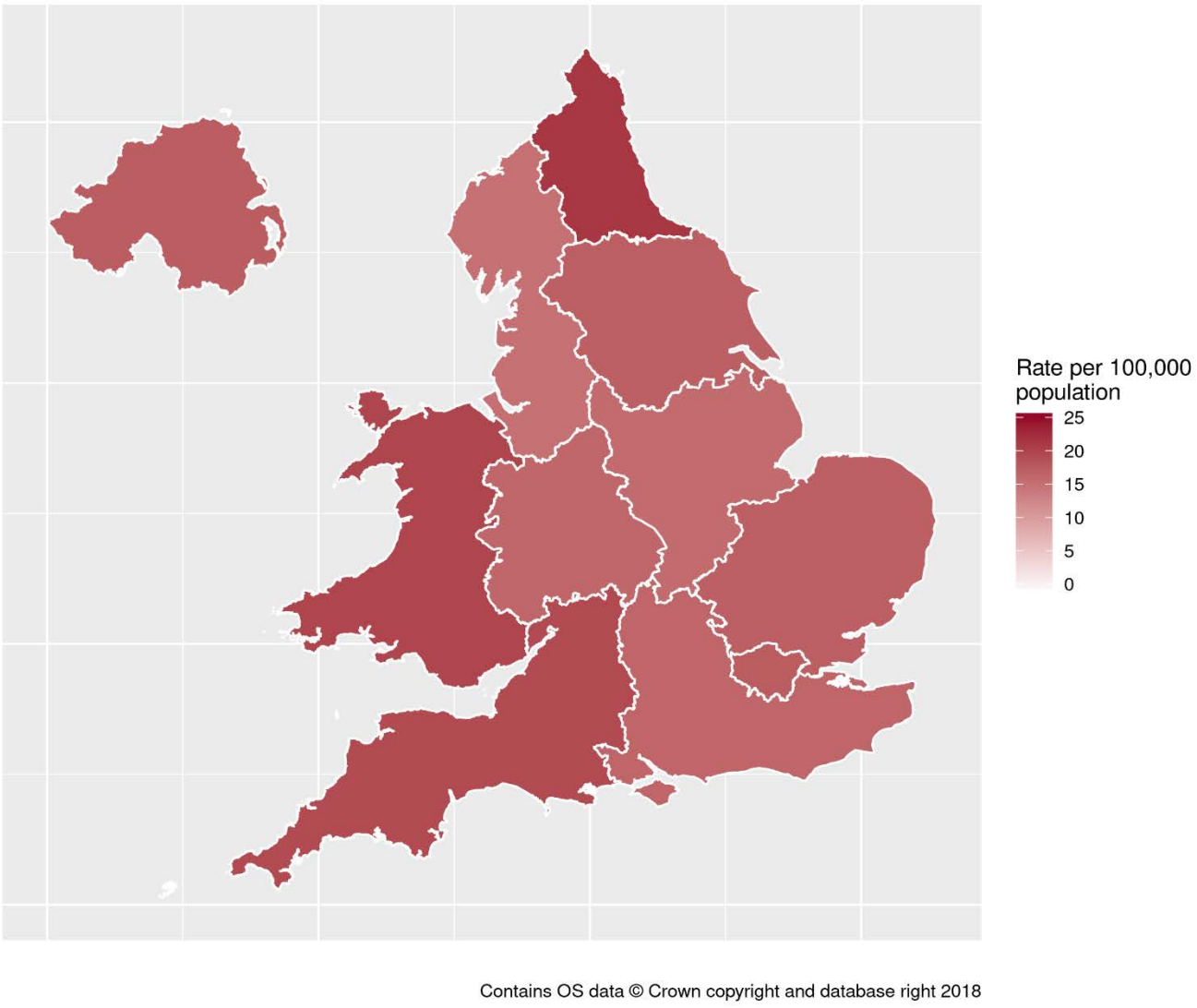


Table 1. *Klebsiella* spp. bacteraemia per 100,000 population by region (England, Wales and Northern Ireland): 2014 to 2018

		Rate, per 100,000 population				
Region	**PHE Centre**	**2014**	**2015**	**2016**	**2017**	**2018**
North of England	North East	13.8	15.4	18.7	20.4	21.6
	North West	14.1	14.5	15.4	15.3	15.1
	Yorkshire and Humber	9.5	10.8	12.3	13.8	17.0
Midlands and East of England	East Midlands	11.3	14.4	17.0	16.8	15.7
	East of England	12.1	12.6	14.6	17.1	17.1
	West Midlands	13.4	14.6	15.0	16.3	16.3
London	London	13.6	14.5	16.0	17.6	17.5
South of England	South East	11.4	11.9	15.6	16.4	16.4
	South West	12.0	13.2	15.7	16.4	19.5
England		12.4	13.4	15.4	16.5	17.0
Northern Ireland		13.2	14.1	14.8	17.9	17.4
Wales		15.4	15.8	17.5	19.2	20.0
England, Northern Ireland and Wales		**12.6**	**13.6**	**15.5**	**16.7**	**17.2**

Species distribution

The most prominent species associated with the majority of infections in 2018 remains *K. pneumoniae* (72.8%). This is followed by the *K. oxytoca* species (16.4%) (Table 2). *K. pneumonia* was the fourth most commonly reported species among all monomicrobial and polymicrobial bacteraemia/and or fungaemia reports in the United Kingdom in 2018 (accounting for 4.1% of monomicrobials and 5.0% of polymicrobials) [4].

The total number of *Klebsiella* spp. bacteraemia reports has continued to increase over the last 5 years (7,446 isolates in 2014 to 10,480 in 2018). Similar to 2017, 97% of reported *Klebsiella* spp. bacteraemia isolates were identified to species level (see Table 2). The number of reports of *K. variicola,* first reported in 2016, continued to increase in 2018 accounting for 3.8% of all reported *Klebsiella* spp. bacteraemia (n= 401). *K. variicola* is very closely related to K*. pneumoniae* so increasing reports may reflect advancements in diagnostic technology in laboratories to allow for further distinction of species [5].

Table 2. Reports of *Klebsiella* spp. bacteraemia by species (England, Wales and Northern Ireland): 2014 to 2018

	2014		2015		2016		2017		2018	
	No.	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**
***Klebsiella* spp.**	**7,446**	**100**	**8,102**	**100**	**9,333**	**100**	**10,105**	**100**	**10,480**	**100**
*K. pneumoniae**	5,627	75.6	6,125	75.6	7,193	77.1	7,461	73.8	7,630	72.8
K. oxytoca	1,361	18.3	1,489	18.4	1,549	16.6	1,713	17.0	1,715	16.4
K. aerogenes	338	4.5	369	4.6	396	4.2	414	4.1	464	4.4
K. variicola	0	0.0	0	0.0	47	0.5	241	2.4	401	3.8
Klebsiella spp., other named	10	0.1	10	0.1	6	0.1	2	< 0.1	4	< 0.1
Klebsiella spp., species not recorded	110	1.5	109	1.3	142	1.5	274	2.7	266	2.5

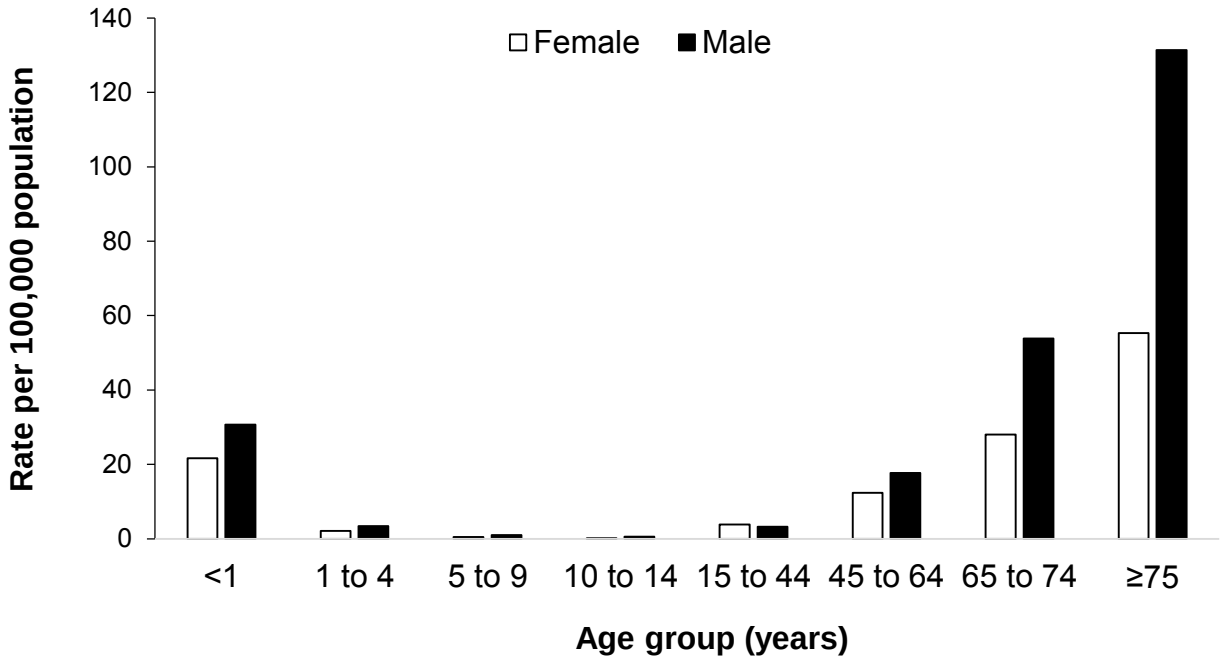
* Includes a small number of the *K. pneumoniae* subspecies *ozaenae* and *K. pneumoniae* subspecies *rhinoscleromatis*

Age and sex distribution

As shown in Figure 3, rates of *Klebsiella* spp. bacteraemia vary by age and sex. Rates are highest amongst the youngest (less than 1 year of age) and oldest age groups (age 65 and older).

For the majority of age groups (all except the 15 to 44 years age group), higher rates are reported for males compared to females. This difference is most pronounced in those aged 75 and older, where the rate of *Klebsiella* spp. bacteraemia in males is 2.4 times higher than females.

Figure 3. *Klebsiella* spp. bacteraemia rates by age and sex (England, Wales and Northern Ireland): 2018



Antimicrobial resistance: England and Northern Ireland

An important feature of *Klebsiella* species is their ability to become resistant to a wide range of antibiotics. Tables 3, 3a and 3b present antibiotic susceptibility trends from 2015 to 2018 for England and Northern Ireland. In 2018, the number of isolates tested for resistance to antimicrobial agents ranged from <1% for netilmicin to 98% for gentamicin.

For *Klebsiella* spp. isolates overall, resistance to third-generation cephalosporins (ceftazidime and cefotaxime) has been slightly increasing since 2015 (ceftazidime: 9% to 13%; cefotaxime: 9% to 12%). In 2018 however, cefotaxime resistance remained the same from the previous year at 12%. Similarly, *K. pneumonia* isolates have shown a slight increase in resistance to third-generation cephalosporins from 2015 (ceftazidime: 10% to 15%; cefotaxime: 9% to 13%). This trend was further confirmed in the recently published 2018 English Surveillance Programme for Antimicrobial Utilisation and Resistance (ESPAUR) report [6]. While resistance to the third-generation cephalosporins remains much lower for *K. oxytoca* isolates, there has also been a slight increase from 2015, more so in the most recent 2 years (ceftazidime: 1% to 3%; cefotaxime: 2% to 6%).

Ciprofloxacin has shown similar slight increases in resistance since 2015 as the third-generation cephalosporins for *Klebsiella* spp. isolates overall (8% to 12%) and *K. pneumonia* isolates (9% to 15%). This was not the case for *K .oxytoca* isolates, which have remained very low at 1-2%.

After a reported high peak in netilmicin resistance in 2017, for *Klebsiella* spp. isolates and *K. pneumonia* isolates in particular, the percentage of netilmicin resistance reported in 2018 decreased back to less than what was originally reported in 2015 (5% in 2018 for *Klebsiella* spp. isolates and 8% for *K.pneumonia* isolates). It is important to note that less than 2% of all reported isolates are tested against this antimicrobial agent hence, annual susceptibility results are highly variable and should be interpreted with caution.

The carbapenem class of antibiotics is considered the last line of defense against Gram-negative infections that are resistant to other antibiotics. As a result, close vigilance of antimicrobial resistance to these antibiotic agents remains important [6]. Resistance to carbapenems (meropenem and ertapenem) remains low among tested *Klebsiella spp.* isolates (2% or less).

Table 3. Antibiotic susceptibility* for *Klebsiella* spp. bacteraemia (England and Northern Ireland): 2015 to 2018

	2015			2016			2017			2018		
Antimicrobial agent	**S (%)**	**I (%)**	**R (%)**	**S (%)**	**I (%)**	**R (%)**	**S (%)**	**I (%)**	**R (%)**	**S (%)**	**I (%)**	**R (%)**
Amikacin	98	1	1	98	1	1	97	2	1	98	1	1
Amoxycillin/Clavulanate	72	0	27	73	0	27	72	0	28	69	0	31
Ceftazidime	90	1	9	89	1	10	87	1	11	86	1	13
Cefotaxime	90	1	9	89	1	10	87	1	12	87	1	12
Ciprofloxacin	91	1	8	91	1	8	89	2	9	86	2	12
Colistin	96	0	4	97	0	3	97	0	3	96	0	4
Ertapenem	98	1	1	99	0	1	98	0	1	98	0	2
Gentamicin	93	0	7	93	0	7	93	0	7	92	0	8
Meropenem	99	0	0	99	0	0	99	0	1	99	0	1
Netilmicin†	92	0	8	89	2	9	76	2	21	92	3	5
Piperacillin/Tazobactam	83	3	14	83	4	14	82	4	13	81	5	14
Tobramycin	90	0	10	90	1	10	90	0	10	89	0	10

* **S** = susceptible; **I** = intermediate (reduced susceptibility); **R** = resistant † ≤ 1% of isolates tested

Table 3a. Antibiotic susceptibility* for *K. pneumoniae* bacteraemia (England and Northern Ireland): 2015 to 2018

	2015			2016			2017			2018		
Antimicrobial agent	**S (%)**	**I (%)**	**R (%)**	**S (%)**	**I (%)**	**R (%)**	**S (%)**	**I (%)**	**R (%)**	**S (%)**	**I (%)**	**R (%)**
Amikacin	98	1	1	97	2	1	97	2	1	97	2	1
Amoxycillin/Clavulanate	73	0	26	74	0	26	72	0	28	69	0	31
Ceftazidime	89	1	10	88	2	10	86	2	13	83	1	15
Cefotaxime	90	1	9	89	1	10	87	1	13	86	0	13
Ciprofloxacin	89	1	9	89	2	10	86	2	11	83	2	15
Colistin	96	0	4	97	0	3	97	0	3	95	0	5
Ertapenem	99	0	1	99	0	1	98	0	1	98	0	2
Gentamicin	92	0	8	92	0	8	91	0	8	90	0	10
Meropenem	99	0	1	99	0	1	99	0	1	99	0	1
Netilmicin†	88	0	12	84	3	13	72	3	25	88	4	8
Piperacillin/Tazobactam	82	4	14	82	4	13	81	5	14	79	6	15
Tobramycin	87	0	12	88	1	11	87	0	12	87	0	13

* **S** = susceptible; **I** = intermediate (reduced susceptibility); **R** = resistant † ≤1% of isolates tested

Table 3b. Antibiotic susceptibility* for *K. oxytoca* bacteraemia (England and Northern Ireland): 2015 to 2018

	2015			2016			2017			2018		
Antimicrobial agent	**S (%)**	**I (%)**	**R (%)**	**S (%)**	**I (%)**	**R (%)**	**S (%)**	**I (%)**	**R (%)**	**S (%)**	**I (%)**	**R (%)**
Amikacin	100	0	0	99	0	0	99	0	0	99	1	0
Amoxycillin/Clavulanate	83	0	17	83	0	17	84	0	16	82	0	18
Ceftazidime	98	0	1	97	0	2	98	1	2	97	1	3
Cefotaxime	97	1	2	97	1	2	95	1	4	93	1	6
Ciprofloxacin	98	0	1	98	0	2	98	0	1	97	0	2
Colistin	98	0	2	97	0	3	98	0	2	98	0	2
Ertapenem	99	0	0	100	0	0	100	0	0	99	0	1
Gentamicin	99	0	1	99	0	1	99	0	1	98	0	2
Meropenem	100	0	0	100	0	0	100	0	0	100	0	0
Netilmicin†	100	0	0	100	0	0	100	0	0	100	0	0
Piperacillin/Tazobactam	89	0	10	87	1	12	88	1	11	86	2	12
Tobramycin	99	0	1	99	0	1	99	0	1	97	0	2

* **S** = susceptible; **I** = intermediate (reduced susceptibility); **R** = resistant † ≤1% of isolates tested

Tables 4a-b show multi-drug resistance testing results for the two most prevalent species of *Klebsiella* for England from 2015 to 2018. This analysis examined combinations for five classes of antibiotics: third-generation cephalosporins (any of cefotaxime, ceftazidime, ceftriaxone or cefpodoxime), a fluoroquinolone (ciprofloxacin), carbapenems (meropenem), a penicillin/beta-lactamase inhibitor combination (piperacillin/tazobactam) and an aminoglycoside (gentamicin).

K. pneumoniae showed higher levels of multi-drug resistance for all tested antibiotic combinations compared to *K. oxytoca*. Of the pairwise antibiotic combinations, the highest reported resistance for both presented species was to the combination of a third-generation cephalosporin and amoxycillin/clavulanate (*K. pneumoniae* isolates: 14%; *K. oxytoca* isolates: 8%). Other high reported resistance combinations for *K. pneumoniae* include 12% for the combination of ciprofloxacin and amoxycillin/clavulanate and 10% for the combination of a third-generation cephalosporin and ciprofloxacin or the multi-drug combination of all three (a third-generation cephalosporin, ciprofloxacin and amoxycillin/clavulanate). For *K. oxytoca*, resistance to the combination of a third-generation cephalosporin and piperacillin/tazobactam or the multi-drug combination of those with amoxycillin/clavulanate were also high at 7%. Resistance to these combinations has continued to increase from 2015. As seen in table 4b, multi-drug resistance for *K. oxytoca* for all other tested drug combinations is low (<2%).

Multi-drug resistance to a combination of four classes of antibiotics remains rare in both species (<1%).

Table 4a. Multi-drug antimicrobial testing and resistance summary† for *K. pneumoniae* bacteraemia (England): 2015 to 2018

Antimicrobial combinations	2015		2016		2017		2018	
	No. tested	R (%)	No. tested	R (%)	No. tested	R (%)	No. tested	R (%)
3rd gen cephalosporin* and ciprofloxacin	5,005	6	6,190	6	6,400	7	6,616	10
3rd gen cephalosporin* and gentamicin	5,071	6	6,240	6	6,392	6	6,618	7
3rd gen cephalosporin* and meropenem	4,897	0	6,108	1	6,335	1	6,619	1
3rd gen cephalosporin* and amoxycillin/clavulanate	4,964	9	6,211	9	6,338	12	6,423	14
3rd gen cephalosporin* and piperacillin/tazobactam	4,940	6	6,018	5	6,163	7	6,503	8
Ciprofloxacin and gentamicin	5,063	6	6,198	6	6,369	6	6,533	7
Ciprofloxacin and meropenem	4,862	0	6,030	0	6,235	1	6,467	1
Ciprofloxacin and amoxycillin/clavulanate	4,948	7	6,169	8	6,301	9	6,349	12
Ciprofloxacin and piperacillin/tazobactam	4,921	5	5,961	4	6,085	5	6,374	7
Gentamicin and meropenem	4,935	0	6,090	0	6,240	0	6,494	1
Gentamicin and amoxycillin/clavulanate	5,053	8	6,249	7	6,359	8	6,383	9
Gentamicin and piperacillin/tazobactam	5,037	4	6,046	4	6,101	4	6,369	5
3rd gen cephalosporin*, ciprofloxacin and gentamicin	4,981	4	6,110	4	6,250	5	6,419	6
3rd gen cephalosporin*, ciprofloxacin and meropenem	4,811	0	5,984	0	6,182	1	6,413	1
3rd gen cephalosporin*, ciprofloxacin and amoxycillin/clavulanate	4,872	5	6,084	6	6,180	7	6,225	10
3rd gen cephalosporin*, ciprofloxacin and piperacillin/ tazobactam	4,851	3	5,899	3	6,022	4	6,306	6
3rd gen cephalosporin*, gentamicin and meropenem	4,874	0	6,038	0	6,176	0	6,420	1
3rd gen cephalosporin*, gentamicin and amoxycillin/clavulanate	4,940	6	6,124	5	6,173	6	6,223	7
3rd gen cephalosporin*, gentamicin and piperacillin/tazobactam	4,917	3	5,943	3	5,999	4	6,302	4
3rd gen cephalosporin*, meropenem and amoxycillin/clavulanate	4,792	0	6,024	1	6,133	1	6,219	1
3rd gen cephalosporin*, meropenem and piperacillin/tazobactam	4,752	0	5,821	0	5,962	1	6,318	1
3rd gen cephalosporin*, amoxycillin/clavulanate and piperacillin/tazobactam	4,822	6	5,911	5	5,940	7	6,114	8
3rd gen cephalosporin*, ciprofloxacin, gentamicin and meropenem	4,790	0	5,919	0	6,052	0	6,239	1

*Any of cefotaxime, ceftazidime, ceftriaxone or cefpodoxime; †defined as reduced- or non-susceptibility

Table 4b. Multi-drug antimicrobial testing and resistance summary† for *K. oxytoca* bacteraemia (England): 2015 to 2018

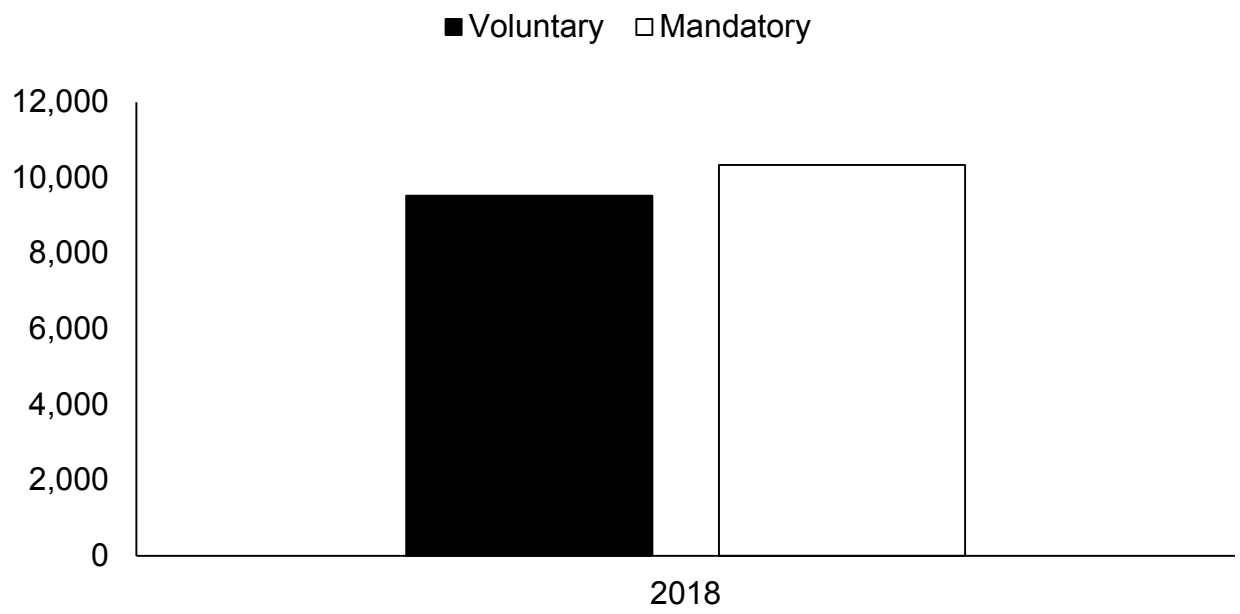
Antimicrobial combinations	2015		2016		2017		2018	
	No. tested	R (%)	No. tested	R (%)	No. tested	R (%)	No. tested	R (%)
3rd gen cephalosporin* and ciprofloxacin	1,302	1	1,388	1	1,503	1	1,462	2
3rd gen cephalosporin* and gentamicin	1,321	0	1,396	1	1,507	0	1,478	2
3rd gen cephalosporin* and meropenem	1,274	0	1,351	0	1,483	0	1,459	0
3rd gen cephalosporin* and amoxycillin/clavulanate	1,299	3	1,380	5	1,485	5	1,422	8
3rd gen cephalosporin* and piperacillin/tazobactam	1,278	3	1,339	4	1,449	5	1,446	7
Ciprofloxacin and gentamicin	1,306	0	1,397	1	1,490	0	1,441	1
Ciprofloxacin and meropenem	1,254	0	1,339	0	1,453	0	1,420	0
Ciprofloxacin and amoxycillin/clavulanate	1,284	1	1,381	1	1,461	1	1,387	2
Ciprofloxacin and piperacillin/tazobactam	1,262	1	1,338	1	1,427	1	1,408	1
Gentamicin and meropenem	1,275	0	1,353	0	1,461	0	1,434	0
Gentamicin and amoxycillin/clavulanate	1,310	0	1,398	1	1,482	1	1,413	2
Gentamicin and piperacillin/tazobactam	1,291	0	1,357	1	1,434	0	1,418	1
3rd gen cephalosporin*, ciprofloxacin and gentamicin	1,298	0	1,377	0	1,472	0	1,422	1
3rd gen cephalosporin*, ciprofloxacin and meropenem	1,251	0	1,333	0	1,442	0	1,411	0
3rd gen cephalosporin*, ciprofloxacin and amoxycillin/clavulanate	1,277	1	1,362	1	1,442	1	1,370	2
3rd gen cephalosporin*, ciprofloxacin and piperacillin/tazobactam	1,257	0	1,323	1	1,416	0	1,397	1
3rd gen cephalosporin*, gentamicin and meropenem	1,270	0	1,344	0	1,449	0	1,423	0
3rd gen cephalosporin*, gentamicin and amoxycillin/clavulanate	1,295	0	1,369	1	1,449	0	1,386	1
3rd gen cephalosporin*, gentamicin and piperacillin/tazobactam	1,275	0	1,329	0	1,413	0	1,407	1
3rd gen cephalosporin*, meropenem and amoxycillin/clavulanate	1,258	0	1,332	0	1,430	0	1,374	0
3rd gen cephalosporin*, meropenem and piperacillin/tazobactam	1,227	0	1,290	0	1,388	0	1,396	0
3rd gen cephalosporin*, amoxycillin/clavulanate and piperacillin/tazobactam	1,255	3	1,316	4	1,391	5	1,352	7
3rd gen cephalosporin*, ciprofloxacin, gentamicin and meropenem	1,247	0	1,326	0	1,419	0	1,376	0

*Any of cefotaxime, ceftazidime, ceftriaxone or cefpodoxime; †defined as reduced- or non-susceptibility

Ascertainment

In England, the government extended the enhanced surveillance of bacteraemia caused by Gram-negative organisms to include *Klebsiella* spp. as of April 2017. As a result, *Klebsiella* spp. bloodstream infections are captured by two systems, the voluntary laboratory surveillance scheme and the mandatory surveillance scheme [7]. Comparisons start in 2018 where a full calendar year is available. Comparing the two systems shows that mandatory surveillance identifies and captures data on more cases than voluntary surveillance does. If we assume all voluntary records also appear in mandatory surveillance, then in 2018 the agreement stood at 92% (Figure 4).

Figure 4. Ascertainment of *Klebsiella* spp. bacteraemia data for the mandatory and voluntary reporting schemes in England: 2018



Microbiology services

For advice on treatment of antibiotic-resistant infections caused by these opportunistic pathogens, laboratories should contact the Medical Microbiologists at PHE's Bacteriology Reference Department in Colindale (colindalemedmicro@phe.gov.uk). For reference services, including species identification and confirmation of sensitivity testing results, laboratories should contact PHE's AMRHAI Reference Unit in London [8].

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Health Protection Report is a national public health bulletin for England and Wales, published by Public Health England. It is PHE's principal channel for the dissemination of laboratory data relating to pathogens and infections/communicable diseases of public health significance and of reports on outbreaks, incidents and ongoing investigations.

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