

***Proteus* spp, *Morganella morganii*, and *Providencia* spp bacteraemias, England, Wales, and Northern Ireland: 2004**

Key points:

Proteeae

- There was little change in the number of *Proteus mirabilis*, *Morganella morganii* and *Providencia stuartii* bacteraemia reports made via the voluntary reporting scheme in England, Wales and Northern Ireland in 2004 compared with 2003, after a marked increase in reporting between 2001 and 2002.

Proteus spp

- Fourteen per cent of all *Proteus* spp reports (281) were not identified beyond genus level, which is similar to reporting from 2001 to 2003 (17%, 15%, and 16% respectively).
- The highest rate of *Proteus* spp bacteraemia reports originated from the North East region (6.01 per 100,000 population), with the lowest rates reported by the South East region (2.60/100,000). It is likely that the observed variation is due to differences in regional reporting practices since the Office for National Statistics mid-2004 population estimates cite the populations of the North East and South East regions as 2.5 million and 8.1 million respectively. A correction factor is currently being developed to enable these reporting rates to be adjusted for differences in regional ascertainment.
- Age specific bacteraemia rates for *Proteus* species bacteraemias were highest in males and especially for those aged 75 years and over, where the rate reported in males (43.92/100,000) was more than double the rate observed in females (17.63/100,000).
- Eighty-one per cent of the *Proteus mirabilis* bacteraemia reports made in 2004 were accompanied by susceptibility information for one or more antibiotics; however, of these reports only 71% to 76% included susceptibility information on the clinically-relevant drugs listed in table 2.
- There was considerable variation between regions in the reporting of relevant susceptibility information for *P. mirabilis* bacteraemia. The greatest variation was observed in the reporting of resistance to ampicillin/amoxicillin (20.0% in Northern Ireland to 38.6% in Wales), ciprofloxacin (1.8 % in the North East region to 16.7% in Wales), and gentamicin (0.0% in the North West region and Northern Ireland to 7.3% in the East of England region).
- One *P. mirabilis* isolate was reported to be resistant to ampicillin, cefuroxime, ciprofloxacin, cefotaxime, ceftazidime, and imipenem, another three isolates were reported as resistant to five of the following ampicillin, cefuroxime, ciprofloxacin, cefotaxime, ceftazidime, and gentamicin.

Morganella morganii

- The highest reporting rate of *M. morganii* bacteraemias was in the North East region (1.06/100,000 population), with the lowest level of reporting from the South East region (0.33/100,000). It is likely that the observed variation is due to differences in regional reporting practices. A correction factor is currently being developed to enable these reporting rates to adjusted for differences in regional ascertainment.
- *M. morganii* bacteraemia reporting rates were highest for those aged 65 to 74 years, and those aged 75 years and over.
- The majority (79%) of *Morganella morganii* bacteraemia reports included susceptibility information to one or more antibiotics.
- Seventy-six per cent of *M. morganii* reports contained susceptibility data for gentamicin, with 8% resistance, unchanged from 2003.

Providencia spp

- There were 97 reports of bacteraemias caused by *Providencia* species made in 2004 from England, Wales, and Northern Ireland. The majority of these reports concerned *P. stuartii* (66%; 64) and *P. rettgeri* (19%; 18).
- Seventy-five per cent of *Providencia stuartii* bacteraemia reports in 2004 included susceptibility information for at least one antimicrobial. Ciprofloxacin resistance was indicated in 1 of the 48 reports (2%). Reports of resistance in *P. stuartii* were only observed in regard to cefotaxime (6%; 1/17) and ciprofloxacin (2%; 1/44). No resistance was reported to amikacin, ceftazidime, or imipenem in 2004.

Introduction

This report details bacteraemias due to *Proteus* species, *Morganella morganii*, and *Providencia* species reported to LabBase2* during 2004 in England, Wales, and Northern Ireland. Rates were calculated using Office for National Statistics (ONS) 2004 mid-year resident population estimates for each region and age group. The analysis presented here was based on data extracted in August 2005; there is no fixed time for the inclusion of data to LabBase2* for these organisms.

The voluntary surveillance scheme for bacteraemias does not distinguish between healthcare-associated and community-acquired bacteraemias.

Regional distribution

Proteus spp

There were 1997 reports received of bacteraemia caused by *Proteus* species in 2004 from England, Wales, and Northern Ireland (table 1 and figure 1). As in 2003, *P. mirabilis* accounted for the majority of *Proteus* spp reports (81%; 1608), with *P. vulgaris* (5%; 90) and *P. penneri* (0.6%; 11) the next most commonly reported. Fourteen per cent of all *Proteus* reports (281) were not identified beyond genus level, which is consistent with data from reporting from 2001 to 2003 (17%, 15%, 16% respectively). The highest rate of *Proteus* bacteraemia reports originated from the North East region (6.01/100,000), with the lowest rates reported by the South East region (2.60/100,000). The overall *Proteus* bacteraemia reporting rate was 3.61/100,000 in England, 3.79/100,000 for Wales, and 4.44/100,000 for Northern Ireland. A correction factor is currently being developed to enable these reporting rates to be adjusted for differences in regional ascertainment.

Age distributions

Age specific bacteraemia rates for *Proteus* species showed a considerable difference between men and women which was most marked in the 75 years and over age group where the rate of *Proteus* spp. bacteraemias reported in males (43.92/100,000) was more than double the rate observed in females (17.63/100,000) (figure 2). The next highest age-specific rate was in the 65 to 74 years age group, which showed a similar gender distribution (11.44/100,000 in males and 7.38/100,000 in females).

Morganella morganii

Four hundred bacteraemia reports for *Morganella morganii* bacteraemias were received from England, Wales, and Northern Ireland in 2004 (table 1 and figure 3). Within England, the North East region had the highest reporting rate (1.06 per 100,000 population), with the lowest reporting rate from the South East region (0.33/100,000). The overall *M. morganii* bacteraemia reporting rate for England was 0.74/100,000, with Wales and Northern Ireland reporting rates for *M. morganii* of 0.58/100,000 and 0.64/100,000 respectively.

Age distributions

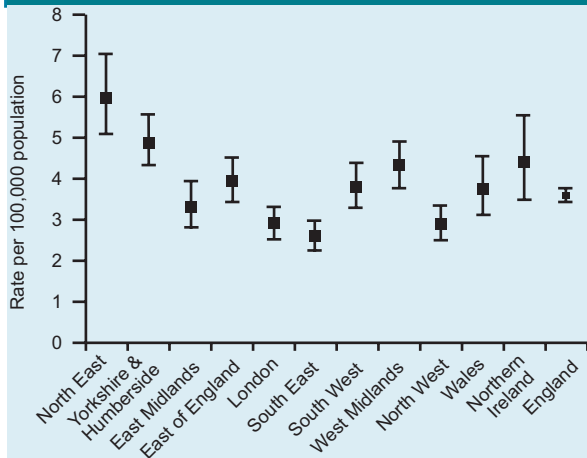
M. morganii bacteraemia reporting rates were highest for those aged 65 to 74 years, and the 75 years and over age groups, with age-specific rates higher in those aged under one year than those seen in the 45 to 64 years age group (figure 4). Within these groups, reported rates showed little difference between the sexes in children aged under one year (0.90/100,000 in males and 0.95/100,000 in females) and in the 75 years and over age groups (4.80/100,000 in males and 4.94/100,000 in females), although the rates in females were marginally higher. This trend was more pronounced in adults in 45 to 64 years and the 65 to 74 years age groups, where age-specific rates are much higher in females (0.44/100,000 in males and 0.76/100,000 in females aged between 45 and 64 years and 1.38/100,000 in

Table 1 Laboratory reports of bacteraemias due to *Proteus* spp, *Morganella morganii*, and *Providencia* spp: England, Wales, and Northern Ireland: 2004

	North East	Yorkshire & Humberside	East Midlands	East of England	London	South East	South West	West Midlands	North West	England	Wales	Northern Ireland (NI)	E,W, & NI
<i>Morganella morganii</i>	27	41	35	45	55	27	40	56	46	372	17	11	400
<i>Proteus mirabilis</i>	126	183	89	185	184	187	144	190	168	1456	82	70	1608
<i>Proteus penneri</i>	–	2	–	1	2	1	3	–	1	10	–	1	11
<i>Proteus vulgaris</i>	10	16	5	6	7	10	3	13	13	83	4	3	90
<i>Proteus</i> spp	13	47	49	24	22	12	42	27	17	253	26	2	281
Other named <i>Proteus</i> spp	4	–	–	1	1	1	–	–	–	7	–	–	7
<i>Providencia alcalifaciens</i>	–	–	–	–	–	1	–	–	–	1	–	–	1
<i>Providencia rettgeri</i>	–	2	2	2	4	–	3	3	1	17	1	–	18
<i>Providencia rustigianii</i>	–	–	–	–	–	1	–	–	–	1	–	1	2
<i>Providencia stuartii</i>	3	7	6	6	10	6	6	9	6	59	1	4	64
<i>Providencia</i> spp	–	4	1	–	1	–	–	1	2	9	–	1	10
Other named <i>Providencia</i> spp	–	–	1	1	–	–	–	–	–	2	–	–	2

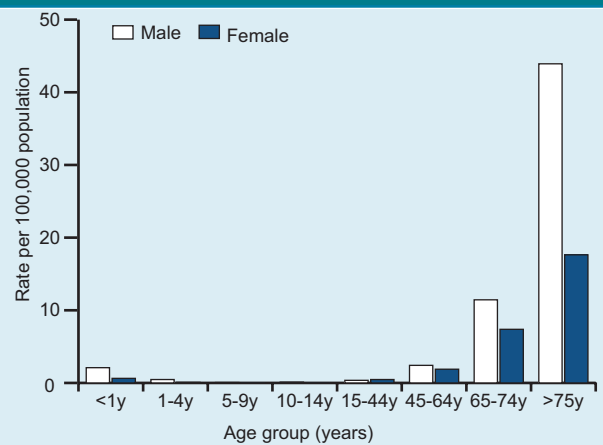
*LabBase2 is the database that is used to collect laboratory reports of all micro-organisms isolated at nearly 400 NHS and other laboratories throughout England and Wales. The database is managed and accessed at the HPA Centre for Infections.

Figure 1 Region-specific rates of bacteraemia due to *Proteus* spp: England, Wales, and Northern Ireland: 2004*



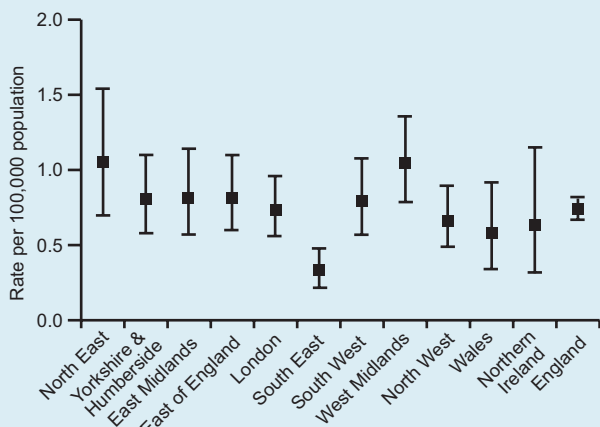
* rates calculated using 2004 mid-year resident population estimates

Figure 2 Age-specific rates of *Proteus* spp bacteraemia reports: England, Wales, and Northern Ireland: 2004*



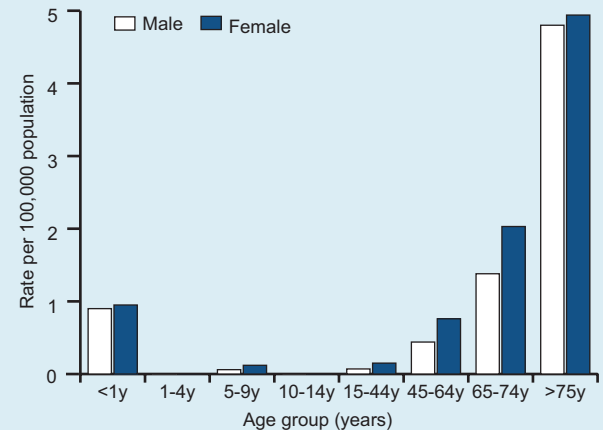
*Rates calculated using 2004 mid-year resident population estimates

Figure 3 Region-specific rates of bacteraemia due to *Morganella morganii*: England, Wales, Northern Ireland: 2004*



* rates calculated using 2004 mid-year resident population estimates

Figure 4 Age-specific rates of *Morganella morganii* spp bacteraemia reports: England, Wales, and Northern Ireland: 2004*



*Rates calculated using 2004 mid-year resident population estimates

males and 2.03/100,000 in females aged from 65 to 74 years).

Providencia spp

There were 97 reports of bacteraemias caused by *Providencia* species made in 2004 from England, Wales, and Northern Ireland. The majority of these reports were due to *P. stuartii* (66%; 64) and *P. rettgeri* (19%; 18) (table 1). Due to the small number of reports, these data are not examined further in this report.

Antimicrobial resistance patterns

Proteus spp

Eighty-one per cent (1303/1608) of the *Proteus mirabilis* bacteraemia reports made in 2004 were accompanied by susceptibility information for one or more antibiotics. The most widely reported antimicrobial was gentamicin (1215; 76%) followed by amoxicillin/ampicillin (1143; 71%) and ciprofloxacin (1137; 71%). Levels of susceptibility

data reporting were lowest for cefotaxime (556; 35%) and ceftazidime (793; 49%), where only 20 reports of cefuroxime resistance (2%; 20/1051), seven reports of cefotaxime resistance (1%; 7/556) and nine reports of ceftazidime resistance (1%; 9/793) in *Proteus mirabilis* bacteraemia isolates were reported from England, Wales, and Northern Ireland in 2004 (figures 6-8).

There was considerable variation between regions in the reporting of susceptibility information for *P. mirabilis* bacteraemia. The greatest variation was observed in the reporting of resistance to ampicillin/amoxicillin (20.0% in Northern Ireland to 38.6% in Wales), ciprofloxacin (0.0% in the Northern Ireland to 16.7% in Wales), and gentamicin (0% in the North West region and Northern Ireland to 7.3% in the East) (figures 5, 9, and 10).

As there were only small numbers of reports of *P. vulgaris* and *P. penneri*, regional breakdowns and multiple resistance patterns were not examined. *P. vulgaris* and *P. penneri* are inherently resistant to ampicillin and cefuroxime.

Figure 5 Ampicillin/amoxycillin susceptibility data for *Proteus mirabilis* reported from bacteraemias, England, Wales, and Northern Ireland: 2004

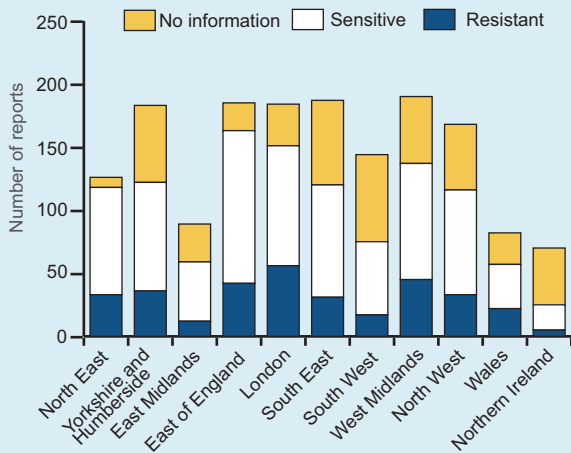


Figure 6 Cefuroxime susceptibility data for *Proteus mirabilis* reported from bacteraemias, England, Wales, and Northern Ireland: 2004

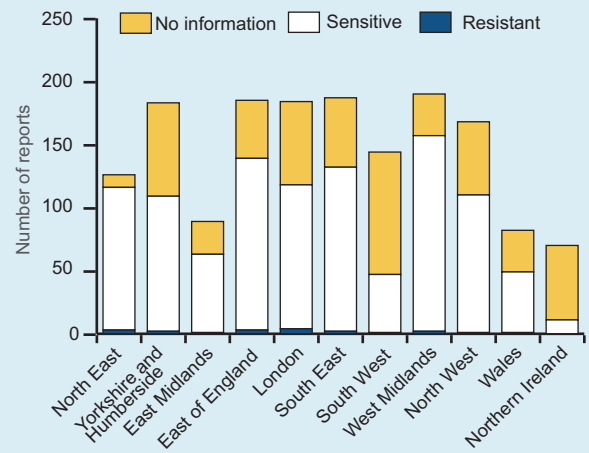


Figure 7 Cefotaxime susceptibility data for *Proteus mirabilis* reported from bacteraemias, England, Wales, and Northern Ireland: 2004

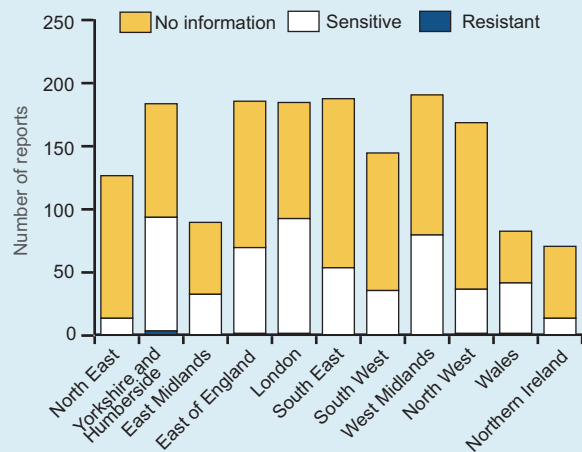


Figure 8 Ceftazidime susceptibility data for *Proteus mirabilis* reported from bacteraemias, England, Wales, and Northern Ireland: 2004

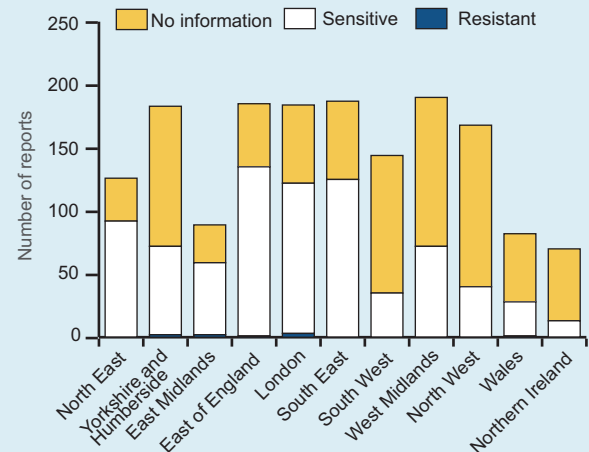


Figure 9 Ciprofloxacin susceptibility data for *Proteus mirabilis* reported from bacteraemias, England, Wales, and Northern Ireland: 2004

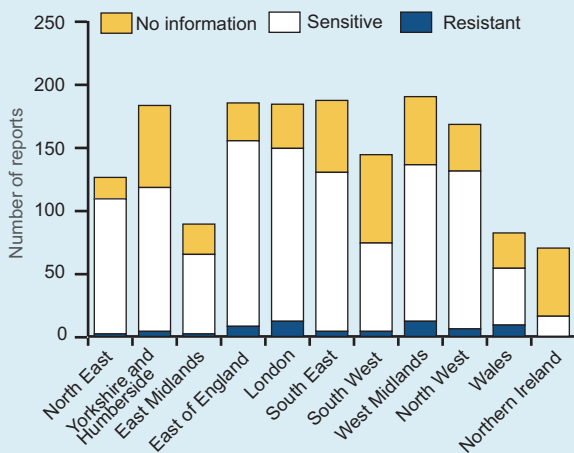
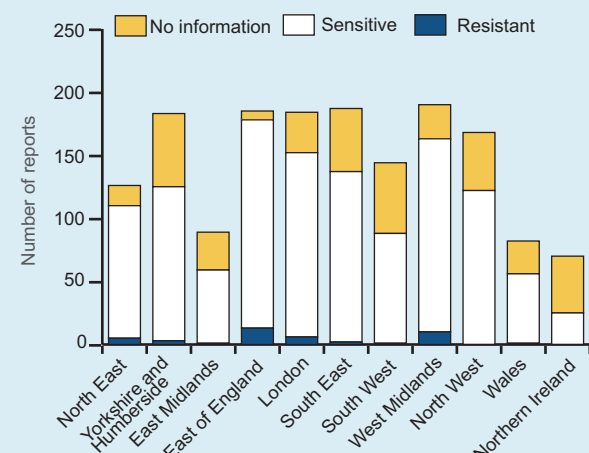


Figure 10 Gentamicin susceptibility data for *Proteus mirabilis* reported from bacteraemias, England, Wales, and Northern Ireland: 2004



Morganella morganii

The majority of *Morganella morganii* bacteraemia reports included susceptibility information to one or more of the antibiotics listed in table 2 (79%). Seventy-six per cent of *M. morganii* reports contained susceptibility data for gentamicin, of which 8% reported resistance to this antimicrobial, which is consistent with reports from 2003 (8%). Resistance to cefotaxime and ceftazidime were reported in 21% and 23% of reports with susceptibility information for these agents. Six per cent of reports with susceptibility data for imipenem were reported to be resistant (which is consistent with 2002 reported resistance levels). Although *M. morganii* is inherently resistant to ampicillin, 8.5% of isolates speciated as *M. morganii* were reported as susceptible, raising issues about the validity of the species identification.

Providencia spp

There were 64 *Providencia stuartii* bacteraemia reports in 2004 (table 2) of which 48 included susceptibility information for at least one antimicrobial. Ciprofloxacin resistance was indicated in one of the 48 reports (2%). Reports of resistance in *P. stuartii* were only observed in regard to cefotaxime (6%; 1/17) and ciprofloxacin (2%; 1/44). No resistance was reported to amikacin, ceftazidime, or imipenem in 2004.

Discussion

Proteus mirabilis was the eighth leading cause of bacteraemia in England, Wales, and Northern Ireland in 2003 (tenth in 2002). Of the Gram-negative bacteria, *P. mirabilis* was ranked as the fifth most common cause of bacteraemia in England, Wales, and Northern Ireland (1, 2).

The total number of bacteraemia laboratory reports for infections due to *Proteus* species and *Morganella morganii* have increased from 1501 reports in 1999 to 2397 in 2004, an increase of 60%, of which a small proportion of this increase (4% of 2004 figures) is attributable to the fact that data presented prior to 2002 did not include reports submitted by Northern Ireland (1-5).

Fourteen per cent of *Proteus* reports (281) were not identified beyond the genus level, which is unfortunate as *Proteus* species differ greatly in their antibiotic susceptibilities. Although the proportion of *P. mirabilis* reports with antimicrobial susceptibility information increased slightly between 2003 and 2004, (77% and 81% respectively), almost 20% of *P. mirabilis* isolates still did not include information on susceptibility to any antimicrobial. The percentage of *M. morganii* isolates reported with antimicrobial susceptibility data for at least one antimicrobial agent also increased during 2004 (from 69.7% in 2003 to 79% in 2004).

One *P. mirabilis* isolate was reported as resistant to all of ampicillin, cefuroxime, ciprofloxacin, cefotaxime, ceftazidime and imipenem. A further three isolates were reported as resistant to a combination of five of the following ampicillin, cefuroxime, ciprofloxacin, cefotaxime, ceftazidime, and gentamicin. The small number of isolates observed with this resistance pattern may be due to the small number of isolates tested against all six antibiotics.

Despite the increasing number of *P. mirabilis* isolates reported with amoxycillin/ampicillin susceptibility data since 2001 the proportion of amoxycillin/ampicillin-resistant reports appears to be stable at approximately 30% (29% in 2004) (3,5, 6). *M. morganii* is also inherently resistant to ampicillin.

Table 2 Antibiotic susceptibilities for *Proteus* spp, *Morganella morganii*, and *Providencia stuartii* bacteraemia laboratory reports, England, Wales, and Northern Ireland: 2004

	Sensitive	Resistant (%) [*]	No information (%) [†]
<i>Proteus mirabilis</i> (n=1608)			
Amoxycillin/ampicillin	811	332 (29)	465 (29)
Cefuroxime	1031	20 (2)	557 (35)
Cefotaxime	549	7 (1)	1052 (65)
Ceftazidime	784	9 (1)	815 (51)
Ciprofloxacin	1074	63 (6)	471 (29)
Gentamicin	1173	42 (3)	393 (24)
<i>Proteus vulgaris</i> (n=90)			
Ciprofloxacin	68	– (–)	22 (24)
Cefotaxime	31	1 (3)	58 (64)
Ceftazidime	46	2 (4)	42 (47)
Gentamicin	67	1 (1)	22 (24)
Imipenem	15	1 (6)	74 (82)
<i>Morganella morganii</i> (n=400)			
Ciprofloxacin	249	32 (11)	119 (30)
Cefotaxime	100	26 (21)	274 (69)
Ceftazidime	157	46 (23)	197 (49)
Gentamicin	281	23 (8)	96 (24)
Imipenem	94	6 (6)	300 (75)
<i>Providencia stuartii</i> (n=64)			
Amikacin	9	– (–)	55 (86)
Ciprofloxacin	43	1 (2)	20 (31)
Cefotaxime	16	1 (6)	47 (73)
Ceftazidime	27	– (–)	37 (58)
Imipenem	12	– (–)	52 (81)

* As a per cent of reports with susceptibility information.

† As a per cent of total reports.

Differences in the reporting of antimicrobial susceptibilities between regions may account for the variation in resistance seen. It is not possible to confirm whether the increases seen in bacteraemias due to the species reported here or the increases in antimicrobial resistance are due to enhanced ascertainment of data (reporting of cases), or whether they reflect a real increase in the number of bacteraemias and a real increase in the levels of antimicrobial resistance. Similarly, it is not possible to determine the cause of variation in levels of reported antimicrobial resistance between regions.

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