Antimicrobial Resistance (AMR) Surveillance Report

Hospital name: **Sunpasitthiprasong Hospital**
Country name: **Thailand**

Data from:
01 Jan 2015 to 31 Dec 2015

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Generated on: **12 Jan 2021**

Generated by

AutoMated tool for Antimicrobial resistance Surveillance System (AMASS)
Version 1.0 (released on February 1, 2019)

The AMASS application used microbiology_data and hospital_admission_data files that are stored in the same folder as the application (AMASS.bat) to generate this report.

The goal of the AMASS application is to enable hospitals with microbiology data available in electronic formats to analyze their own data and generate AMR surveillance reports promptly. If hospital admission date data are available, the reports will additionally be stratified by infection origin (community–origin or hospital–origin). If mortality data (such as patient discharge outcome data) are available, a report on mortality involving AMR infection will be added.

This automatically generated report has limitations, and requires users to understand those limitations and use the summary data in the report with careful interpretation.

A valid report could have local implications and much wider benefits if shared with national and international organizations.

This automatically generated report is under the jurisdiction of the hospital to copy, redistribute, and share with any individual or organization.

This automatically generated report contains no patient identifier, similar to standard reports on cumulative antimicrobial susceptibility.

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Suggested title for citation:
Antimicrobial resistance surveillance report, Sunpasitthiprasong Hospital, Thailand, 01 Jan 2015 to 31 Dec 2015.

Content

Introduction

Antimicrobial resistance (AMR) is a global health crisis [1]. The report by Lord Jim O'Neill estimated that 700,000 global deaths could be attributable to AMR in 2015, and projected that the annual death toll could reach 10 million by 2050 [1]. However, data of AMR surveillance from low and middle–income countries (LMICs) are scarce [1,2], and data of mortality associated with AMR infections are rarely available. A recent study estimated that 19,000 deaths are attributable to AMR infections in Thailand annually, using routinely available microbiological and hospital databases [3]. The study also proposed that hospitals in LMICs should utilize routinely available microbiological and hospital admission databases to generate reports on AMR surveillance systematically [3].

Reports on AMR surveillance can have a wide range of benefits [2]; including
- characterization of the frequency of resistance and organisms in different facilities and regions;
- prospective and retrospective information on emerging public health threats;
- evaluation and optimization of local and national standard treatment guidelines;
- evaluation of the impact of interventions beyond antimicrobial guidelines that aim to reduce AMR; and
- data sharing with national and international organizations to support decisions on resource allocation for interventions against AMR and to inform the implementation of action plans at national and global levels.

When reporting AMR surveillance results, it is generally recommended that (a) duplicate results of bacterial isolates are removed, and (b) reports are stratified by infection origin (community–origin or hospital–origin), if possible [2]. Many hospitals in LMICs lack time and resources needed to analyze the data (particularly to deduplicate data and to generate tables and figures), write the reports, and to release the data or reports [4].

AutoMated tool for Antimicrobial resistance Surveillance System (AMASS) was developed as an offline, open–access and easy–to–use application that allows a hospital to perform data analysis independently and generate isolate–based and sample–based surveillance reports stratified by infection origin from routinely collected electronic databases. The application was built in R, which is a free software environment. The application has been placed within a user–friendly interface that only requires the user to double–click on the application icon. The AMASS application can be downloaded at:
http://www.amass.website

Please note that the AMASS application and the automatically–generated report have limitations, and require readers to understand those limitations and review the reports and summary data carefully. We encourage the user of the AMASS application to perform manual validation (such as printing and listing isolates of the species to cross check with the reports), as recommended by Clinical and Laboratory Standards Insitute (CLSI) [5] and European Antimicrobial Resistance Surveillance Network (EUCAST) [6,7]. Moreover, it is important to note that the AMASS is an add–on automatized report generating tool and does not replace WHONET, Laboratory Information System (LIS), quality assurance programme, or antimicrobial surveillance systems (including the WHO GLASS).

References:

[1] O'Neill J. (2014) Antimicrobial resistance: tackling a crisis for the health and wealth of nations. Review on antimicrobial resistance. http://amr–review.org. (accessed on 3 Dec 2018).

[2] World Health Organization (2018) Global Antimicrobial Resistance Surveillance System (GLASS) Report. Early implantation 2016–2017. http://apps.who.int/iris/bitstream/handle/10665/259744/9789 241513449–eng.pdf. (accessed on 3 Dec 2018)

[3] Lim C., et al. (2016) Epidemiology and burden of multidrug–resistant bacterial infection in a developing country. Elife 5: e18082.

[4] Ashley EA, Shetty N, Patel J, et al. Harnessing alternative sources of antimicrobial resistance data to support surveillance in low–resource settings. J Antimicrob Chemother. 2019; 74(3):541–546.

[5] Clinical and Laboratory Standards Institute (CLSI). Analysis and Presentation of Cumulative Antimicrobial Susceptibility Test Data, 4th Edition. 2014. (accessed on 21 Jan 2020)

[6] European Antimicrobial Resistance Surveillance Network (EARS–Net). Antimicrobial resistance (AMR) reporting protocol 2018. (accessed on 21 Jan 2020)

[7] European Committee on Antimicrobial Susceptibility Testing (EUCAST). www.eucast.org (accessed on 21 Jan 2020)

Section [1]: Data overview

Introduction

An overview of the data detected by the AMASS application is generated by default. The summary is based on the raw data files saved within the same folder as the application file (AMASS.bat).

Please review and validate this section carefully before proceeds to the next section.

Results

The microbiology_data file (stored in the same folder as the application file) had:

56371   specimen data records with collection dates ranging from

01 Jan 2015 to *31 Dec 2015*

The hospital_admission_data file (stored in the same folder as the application file) had:

101754   admission data records with hospital admission dates ranging from

01 Jan 2015 to *31 Dec 2015*

Notes:

[1] If the periods of the data in microbiology_data and hospital_admission_data files are not similar, the automatically–generated report should be interpreted with caution. The AMASS generates the reports based on the available data.

Reporting period by months:

Data was stratified by month to assist detection of missing data, and verification of whether the month distribution of data records in microbiology_data file and hospital_ admission_data file reflected the microbiology culture frequency and admission rate of the hospital, respectively. For example if the number of specimens in the microbiology_data file reported below is lower than what is expected, please check the raw data file and data dictionary files.

Month	Number of specimen data records in microbiology_data file	Number of admission data records in hospital_admission_data file
January	*4393*	*8443*
February	*4278*	*7636*
March	*4611*	*8616*
April	*4314*	*7994*
May	*4321*	*8230*
June	*4825*	*8744*
July	*4998*	*8600*
August	*5326*	*9114*
September	*4990*	*8951*
October	*4997*	*8833*
November	*4718*	*8286*
December	*4600*	*8307*
Total:	*56371*	*101754*

Note:

[1] Additional general demographic data will be made available in the next version of the AMASS application.

Section [2]: Isolate–based surveillance report

Introduction

An isolate–based surveillance report is generated by default, even if the hospital_ admission_data file is unavailable. This is to enable hospitals with only microbiology data available to utilize the de–duplication and report generation functions of AMASS.
This report is without stratification by origin of infection.

The report generated by the AMASS application version 1.0 includes only blood samples. The next version of AMASS will include other specimen types, including cerebrospinal fluid (CSF), urine, stool, and other specimens.

Organisms under this survey:

    – *Staphylococcus aureus*

    – *Enterococcus* spp.

    – *Streptococcus pneumoniae*

    – *Salmonella* spp.

    – *Escherichia coli*

    – *Klebsiella pneumoniae*

    – *Pseudomonas aeruginosa*

    – *Acinetobacter* spp.

Results

The microbiology_data file had:

Sample collection dates ranged from **01 Jan 2015** to **31 Dec 2015**

Number of records of blood specimens collected within the above date range:

56316 blood specimens records

Number of records of blood specimens with *negative culture (no growth):

50030 blood specimens records

Number of records of blood specimens with culture positive for a microorganism:

6286 blood specimens records

Number of records of blood specimens with culture positive for organism under this survey:

2899 blood specimens records

The AMASS application de–duplicated the data by including only the first isolate per patient per specimen type per evaluation period as described in the method. The number of patients with positive samples is as follows:

Organism	Number of records of blood specimens culture positive for the organism	**Number of patients with blood culture positive for the organism (de–duplicated)
Staphylococcus aureus	*435*	*212*
Enterococcus spp.	*185*	*123*
Streptococcus pneumoniae	*74*	*43*
Salmonella spp.	*137*	*62*
Escherichia coli	*973*	*524*
Klebsiella pneumoniae	*485*	*281*
Pseudomonas aeruginosa	*198*	*117*
Acinetobacter spp.	*412*	*246*
Total:	*2899*	*1608*

*The negative culture included data values specified as 'no growth' in the dictionary_for_ microbiology_data file (details on data dictionary files are in the method section) to represent specimens with negative culture for any microorganism.
**Only the first isolate for each patient per specimen type, per pathogen, and per evaluation period was included in the analysis.

The following figures and tables show the proportion of patients with blood culture positive for antimicrobial non–susceptible isolates.

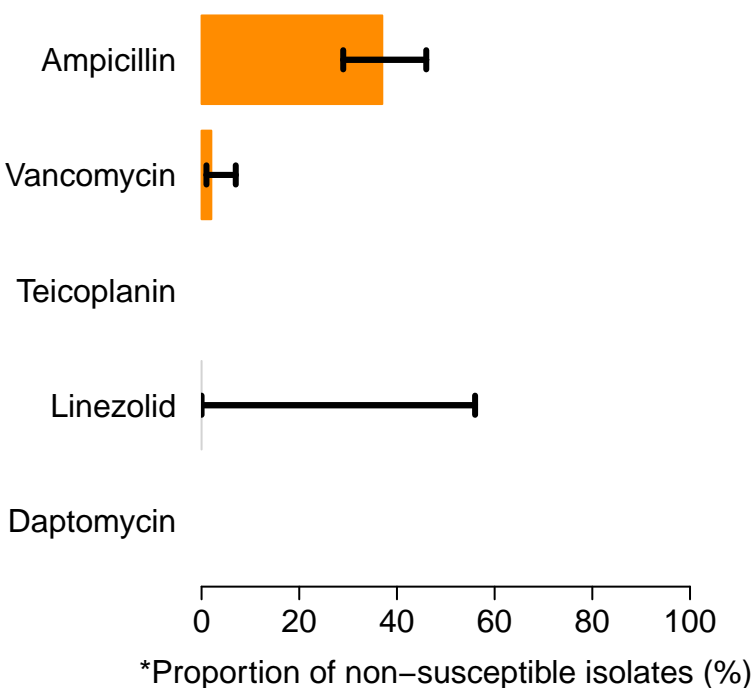# Section [2]: Isolate–based surveillance report

Blood: *Staphylococcus aureus*   **(No. of patients = 212)**

*Proportion of non–susceptible isolates (%)
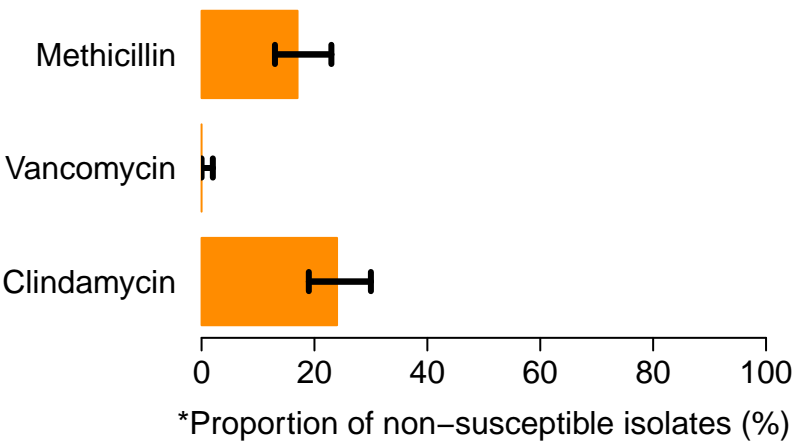
Antibiotic agent	% NS (n)	95% CI
Methicillin	17% (37/212)	13%–23%
Vancomycin	0% (0/212)	0%–2%
Clindamycin	24% (51/212)	19%–30%

**Blood:** *Enterococcus* spp.   **(No. of patients = 123)**

*Proportion of non–susceptible isolates (%)

Antibiotic agent	% NS (n)	95% CI
Ampicillin	37% (46/123)	29%–46%
Vancomycin	2% (3/123)	1%–7%
Teicoplanin	NA	–
Linezolid	0% (0/3)	0%–56%
Daptomycin	NA	–

*Proportion of non–susceptible isolates (% NS) represents the number of patients with blood culture positive for non–susceptible isolates (numerator) over the total number of patients with blood culture positive for the organism and the organism was tested for susceptibility against the antibiotic (denominator). The AMASS application de–duplicated the data by including only the first isolate per patient per specimen type per evaluation period. Grey bars indicate that testing with the antibiotic occurred for less than 70% of the total number of patients with blood culture positive for the organism.
CI = confidence interval; NA = Not available/reported/tested; Methicillin: methicillin, oxacillin, or cefoxitin

Section [2]: Isolate–based surveillance report

Blood: *Streptococcus pneumoniae*   **(No. of patients = 43)**

*Proportion of non–susceptible isolates (%)
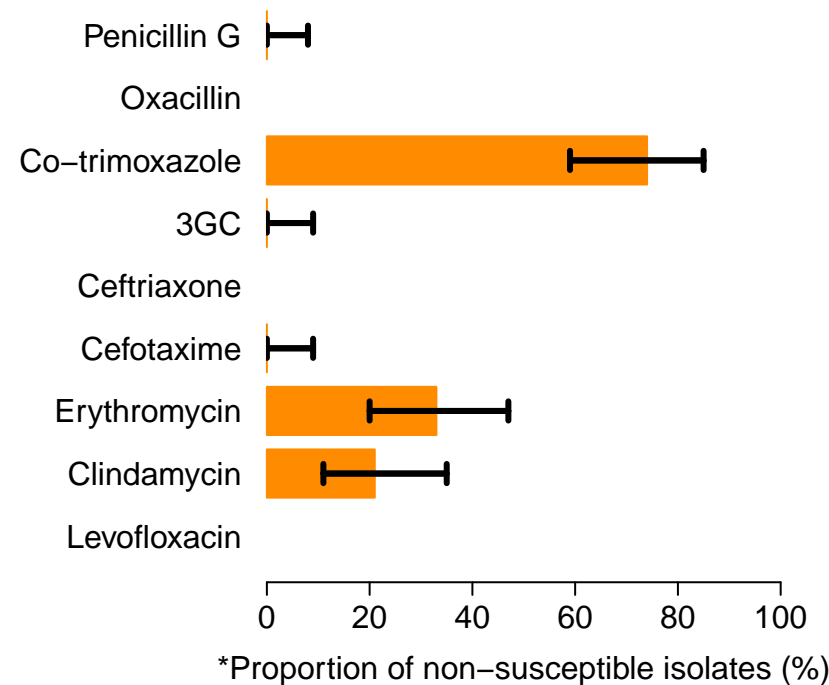
Antibiotic agent	% NS (n)	95% CI
Penicillin G	0% (0/42)	0%–8%
Oxacillin	NA	–
Co–trimoxazole	74% (31/42)	59%–85%
3GC	0% (0/41)	0%–9%
Ceftriaxone	NA	–
Cefotaxime	0% (0/41)	0%–9%
Erythromycin	33% (14/43)	20%–47%
Clindamycin	21% (9/43)	11%–35%
Levofloxacin	NA	–

**Blood:** *Salmonella* spp.   **(No. of patients = 62)**

*Proportion of non–susceptible isolates (%)
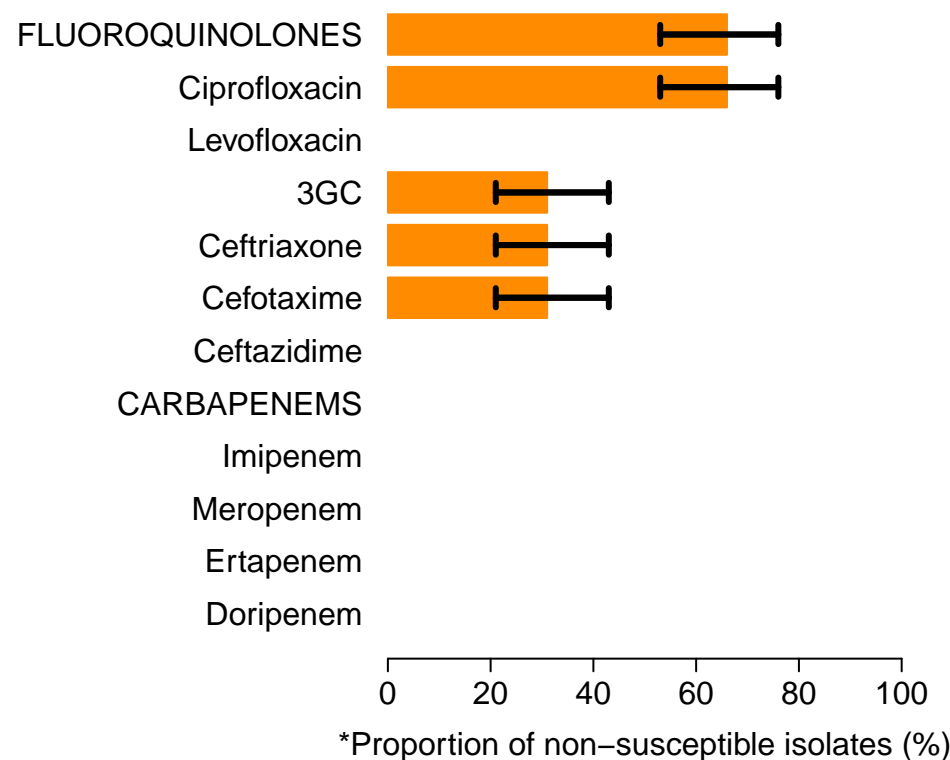
Antibiotic agent	% NS (n)	95% CI
FLUOROQUINOLONES	66% (40/61)	53%–76%
Ciprofloxacin	66% (40/61)	53%–76%
Levofloxacin	NA	–
3GC	31% (19/62)	21%–43%
Ceftriaxone	31% (19/62)	21%–43%
Cefotaxime	31% (19/62)	21%–43%
Ceftazidime	NA	–
CARBAPENEMS	NA	–
Imipenem	NA	–
Meropenem	NA	–
Ertapenem	NA	–
Doripenem	NA	–

*Proportion of non–susceptible isolates (% NS) represents the number of patients with blood culture positive for non–susceptible isolates (numerator) over the total number of patients with blood culture positive for the organism and the organism was tested for susceptibility against the antibiotic (denominator). The AMASS application de–duplicated the data by including only the first isolate per patient per specimen type per evaluation period. Grey bars indicate that testing with the antibiotic occurred for less than 70% of the total number of blood culture positive for the organism.

CI = confidence interval; NA = Not available/reported/tested; 3GC = 3rd–generation cephalosporin;
FLUOROQUINOLONES: ciprofloxacin or levofloxacin; CARBAPENEMS: imipenem, meropenem, ertapenem or doripenem

Section [2]: Isolate–based surveillance report

Blood: *Escherichia coli*   *(No. of patients = 524)*
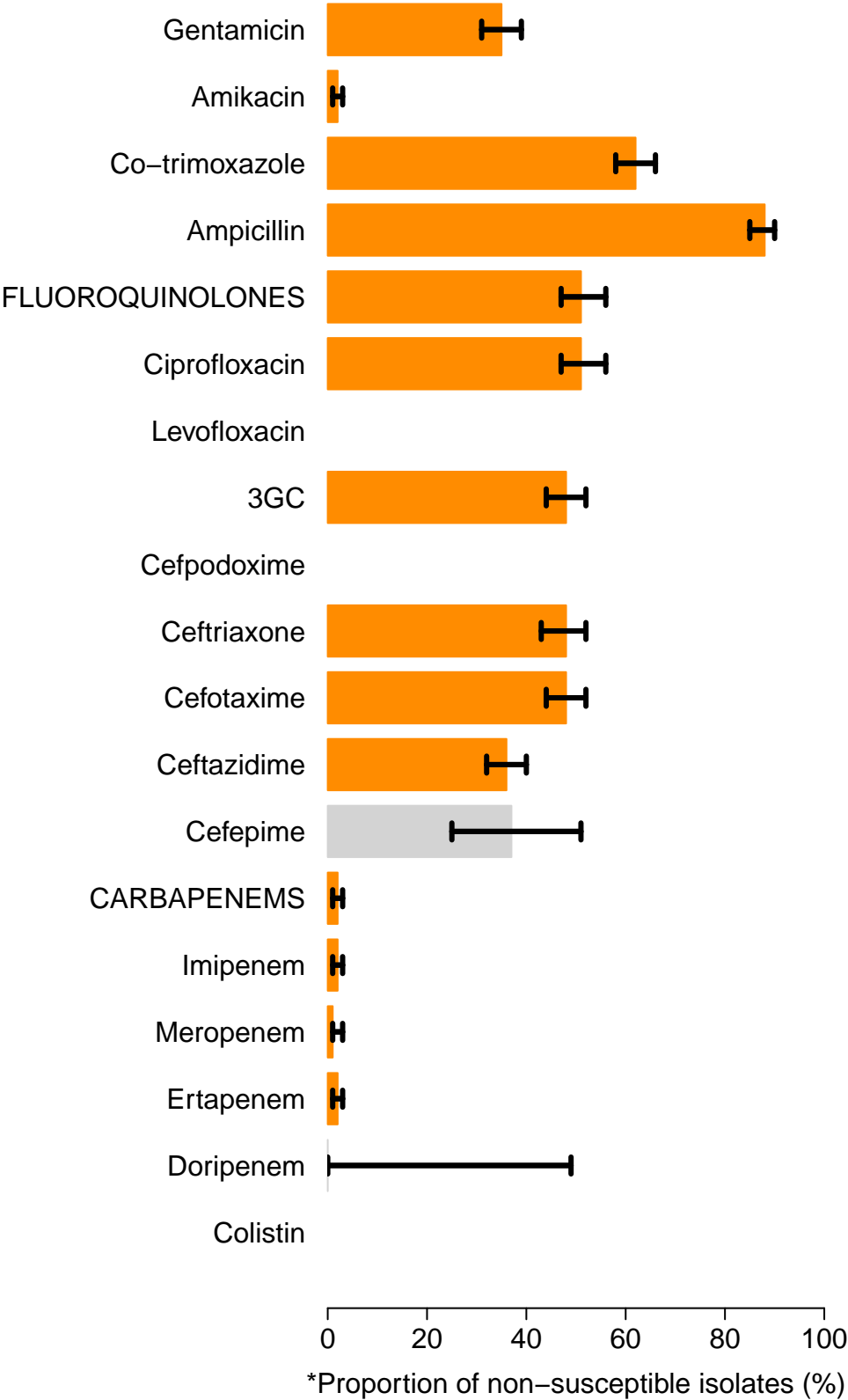
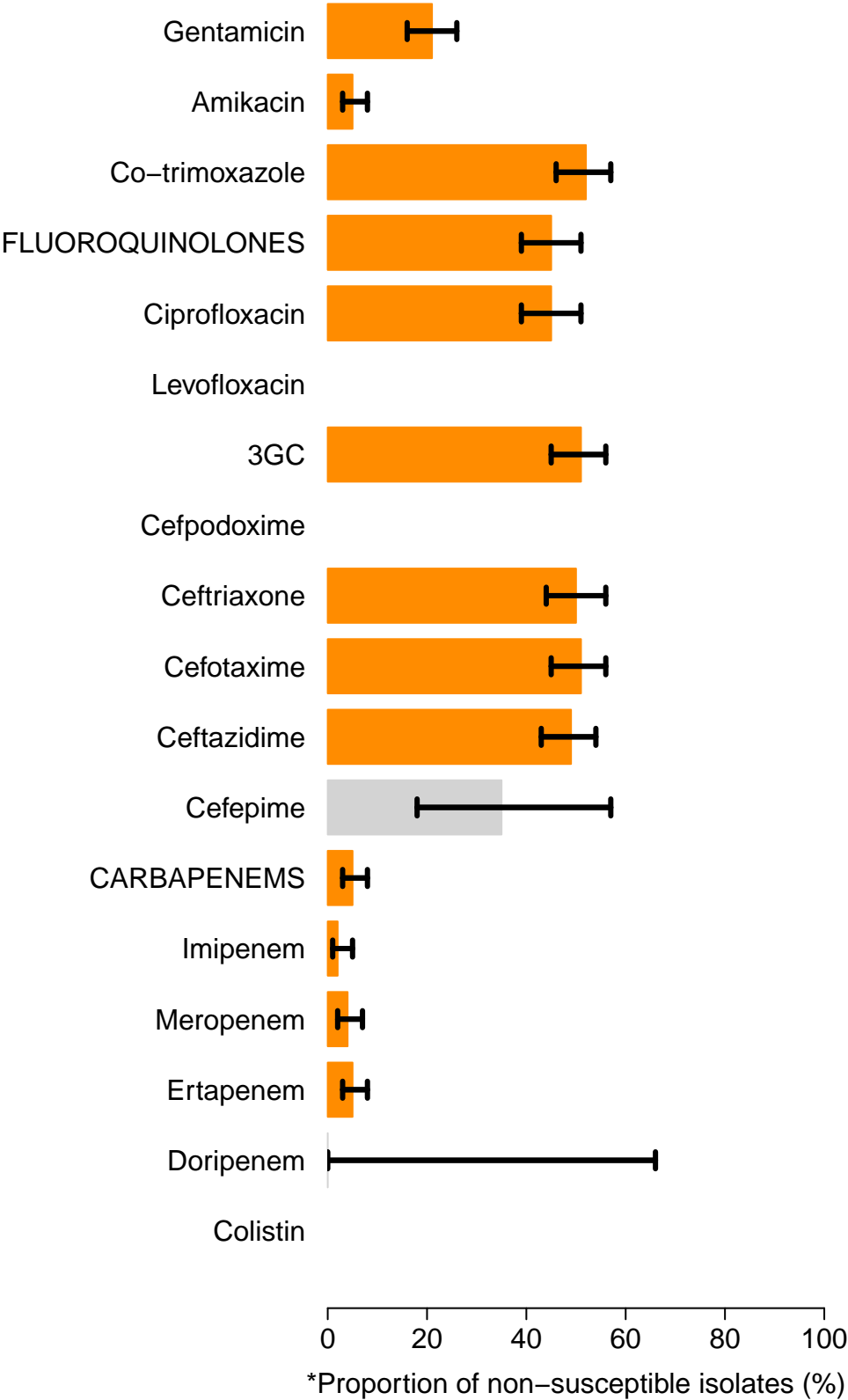| Antibiotic agent	% NS (n)	95% CI
Gentamicin	35% (183/522)	31%–39%
Amikacin	2% (10/524)	1%–3%
Co–trimoxazole	62% (325/524)	58%–66%
Ampicillin	88% (461/524)	85%–90%
FLUOROQUINOLONES	51% (265/515)	47%–56%
Ciprofloxacin	51% (265/515)	47%–56%
Levofloxacin	NA	–
3GC	48% (251/524)	44%–52%
Cefpodoxime	NA	–
Ceftriaxone	48% (249/524)	43%–52%
Cefotaxime	48% (251/524)	44%–52%
Ceftazidime	36% (182/504)	32%–40%
Cefepime	37% (19/51)	25%–51%
CARBAPENEMS	2% (9/523)	1%–3%
Imipenem	2% (8/523)	1%–3%
Meropenem	1% (6/417)	1%–3%
Ertapenem	2% (9/518)	1%–3%
Doripenem	0% (0/4)	0%–49%
Colistin	NA	–

*Proportion of non–susceptible isolates (%)

*Proportion of non–susceptible isolates (% NS) represents the number of patients with blood culture positive for non–susceptible isolates (numerator) over the total number of patients with blood culture positive for the organism and the organism was tested for susceptibility against the antibiotic (denominator). The AMASS application de–duplicated the data by including only the first isolate per patient per specimen type per evaluation period. Grey bars indicate that testing with the antibiotic occurred for less than 70% of the total number of blood culture positive for the organism.

CI = confidence interval; NA = Not available/reported/tested; 3GC = 3rd–generation cephalosporin; FLUOROQUINOLONES: ciprofloxacin or levofloxacin; CARBAPENEMS: imipenem, meropenem, ertapenem or doripenem

Section [2]: Isolate–based surveillance report

Blood: *Klebsiella pneumoniae*　　　　　*(No. of patients = 281)*

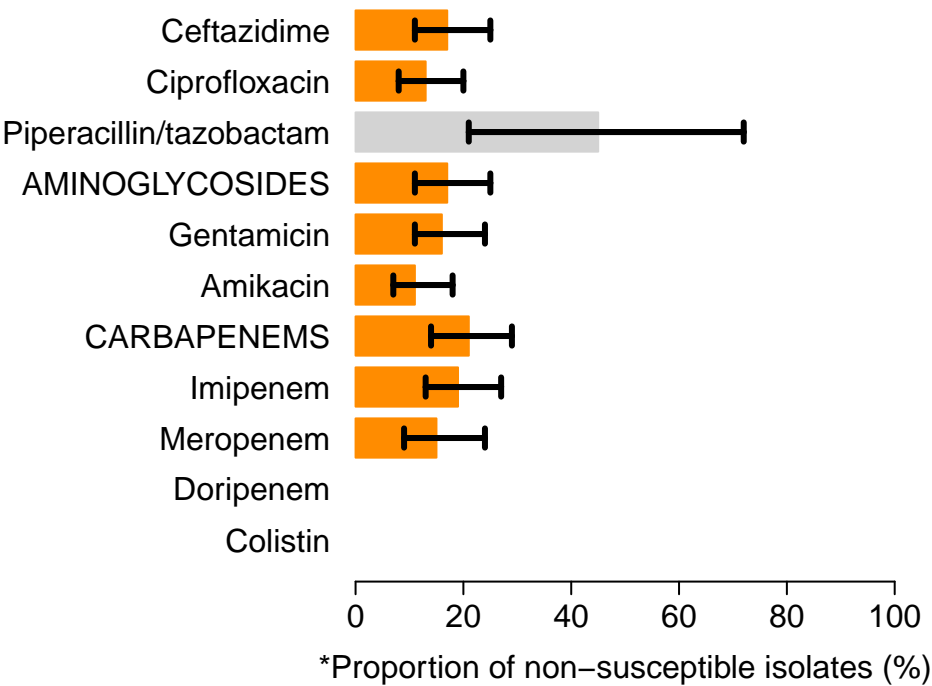| Antibiotic agent	% NS (n)	95% CI
Gentamicin	21% (58/281)	16%–26%
Amikacin	5% (14/281)	3%–8%
Co–trimoxazole	52% (145/281)	46%–57%
FLUOROQUINOLONES	45% (125/278)	39%–51%
Ciprofloxacin	45% (125/278)	39%–51%
Levofloxacin	NA	–
3GC	51% (142/281)	45%–56%
Cefpodoxime	NA	–
Ceftriaxone	50% (141/281)	44%–56%
Cefotaxime	51% (142/281)	45%–56%
Ceftazidime	49% (135/278)	43%–54%
Cefepime	35% (7/20)	18%–57%
CARBAPENEMS	5% (14/281)	3%–8%
Imipenem	2% (6/281)	1%–5%
Meropenem	4% (8/224)	2%–7%
Ertapenem	5% (14/278)	3%–8%
Doripenem	0% (0/2)	0%–66%
Colistin	NA	–

*Proportion of non–susceptible isolates (%)

*Proportion of non–susceptible isolates (% NS) represents the number of patients with blood culture positive for non–susceptible isolates (numerator) over the total number of patients with blood culture positive for the organism and the organism was tested for susceptibility against the antibiotic (denominator). The AMASS application de–duplicated the data by including only the first isolate per patient per specimen type per evaluation period. Grey bars indicate that testing with the antibiotic occurred for less than 70% of the total number of blood culture positive for the organism.

CI = confidence interval; NA = Not available/reported/tested; 3GC = 3rd–generation cephalosporin;
FLUOROQUINOLONES: ciprofloxacin or levofloxacin; CARBAPENEMS: imipenem, meropenem, ertapenem or doripenem

Section [2]: Isolate–based surveillance report

Blood: *Pseudomonas aeruginosa*   **(No. of patients = 117)**

*Proportion of non–susceptible isolates (%)

Antibiotic agent	% NS (n)	95% CI
Ceftazidime	17% (20/117)	11%–25%
Ciprofloxacin	13% (15/117)	8%–20%
Piperacillin/tazobactam	45% (5/11)	21%–72%
AMINOGLYCOSIDES	17% (20/117)	11%–25%
Gentamicin	16% (19/117)	11%–24%
Amikacin	11% (13/117)	7%–18%
CARBAPENEMS	21% (24/117)	14%–29%
Imipenem	19% (22/117)	13%–27%
Meropenem	15% (14/92)	9%–24%
Doripenem	NA	–
Colistin	NA	–

Blood: *Acinetobacter* spp.   **(No. of patients = 246)**

*Proportion of non–susceptible isolates (%)
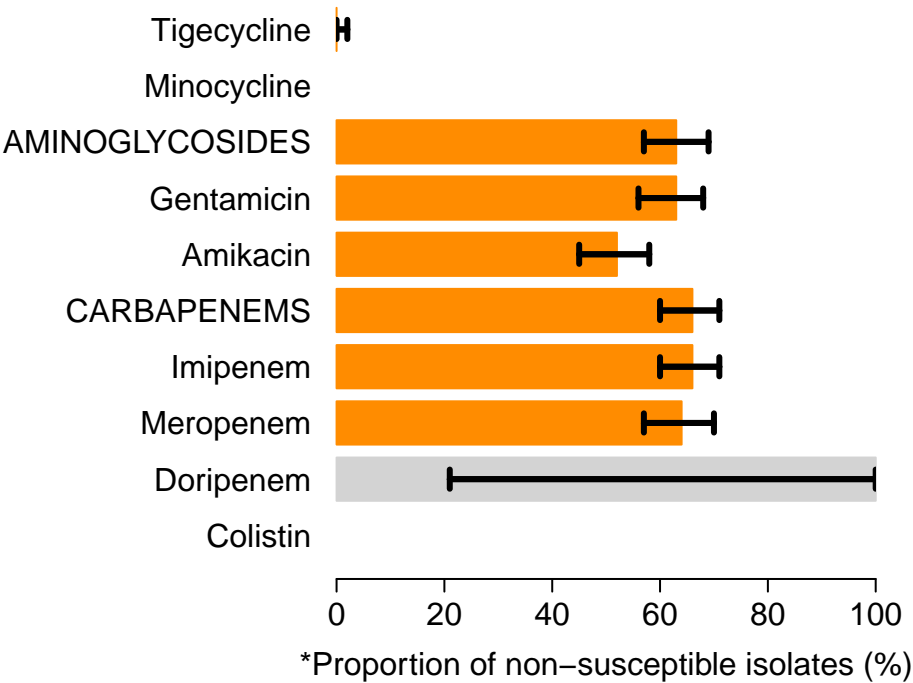
Antibiotic agent	% NS (n)	95% CI
Tigecycline	0% (0/208)	0%–2%
Minocycline	NA	–
AMINOGLYCOSIDES	63% (156/246)	57%–69%
Gentamicin	63% (154/246)	56%–68%
Amikacin	52% (127/246)	45%–58%
CARBAPENEMS	66% (162/246)	60%–71%
Imipenem	66% (162/246)	60%–71%
Meropenem	64% (125/196)	57%–70%
Doripenem	100% (1/1)	21%–100%
Colistin	NA	–

*Proportion of non–susceptible isolates (% NS) represents the number of patients with blood culture positive for non–susceptible isolates (numerator) over the total number of patients with blood culture positive for the organism and the organism was tested for susceptibility against the antibiotic (denominator). The AMASS application de–duplicated the data by including only the first isolate per patient per specimen type per evaluation period. Grey bars indicate that testing with the antibiotic occurred for less than 70% of the total number of blood culture positive for the organism.
CI = confidence interval; NA = Not available/reported/tested; AMINOGLYCOSIDES: either gentamicin or amikacin; CARBAPENEMS: imipenem, meropenem, ertapenem or doripenem

Section [3]: Isolate–based surveillance report with stratification by infection origin

Introduction

An isolate–based surveillance report with stratification by origin of infection is generated only if admission date data are available in the raw data file(s) with the appropriate specification in the data dictionaries.

Stratification by origin of infection is used as a proxy to define where the bloodstream infection (BSI) was contracted (hospital versus community).

The definitions of infection origin proposed by the WHO GLASS are used. In brief, community–origin BSI is defined as patients in the hospital for less than or equal to two calendar days when the first specimen culture postive for the pathogen was taken. Hospital–origin BSI is defined as patients admitted for more than two calendar days when the first specimen culture positive for the pathogen was taken.

Results:

The data included in the analysis to generate the report had:

Sample collection dates ranged from **01 Jan 2015** to **31 Dec 2015**

*Number of patients with blood culture positive for pathogen under the survey:

1608 patients

**Number of patients with community–origin BSI:

936 patients

**Number of patients with hospital–origin BSI:

607 patients

***Number of patients with unknown infection of origin status:

65 patients

Organism	Number of patients with blood culture positive for the organism	Community –origin**	Hospital –origin**	Unknown origin***
Staphylococcus aureus	212	148	57	7
Enterococcus spp.	123	61	54	8
Streptococcus pneumoniae	43	38	4	1
Salmonella spp.	62	52	9	1
Escherichia coli	524	400	110	14
Klebsiella pneumoniae	281	140	126	15
Pseudomonas aeruginosa	117	35	74	8
Acinetobacter spp.	246	62	173	11
Total:	1608	936	607	65

Note:

NA= Not applicable (hospital admission date or infection origin data are not available)

*Only the first isolate for each patient per specimen type per pathogen under the reporting period is included in the analysis. Please refer to Section [2] for details on how this number was calculated from the raw microbiology_data file.
**The definitions of infection origin proposed by the WHO GLASS is used. In brief, community–origin BSI was defined as patients in the hospital for less than or equal to two calendar days when the first blood culture positive for the pathogen was taken.
Hospital–origin BSI was defined as patients admitted for more than two calendar days when the first specimen culture positive for the pathogen was taken.
Please refer to the 'Methods' section for more details on the definitions used.
***Unknown origin could be because admission date data are not available or the patient was not hospitalised.

The following figures and tables below show the proportion of patients with blood culture positive for antimicrobial non–susceptible isolates stratified by infection of origin.

Section [3]: Isolate–based surveillance report with stratification by infection origin

Blood: *Staphylococcus aureus* **Community–origin** *(No. of patients = 148)*

*Proportion of non–susceptible isolates (%)
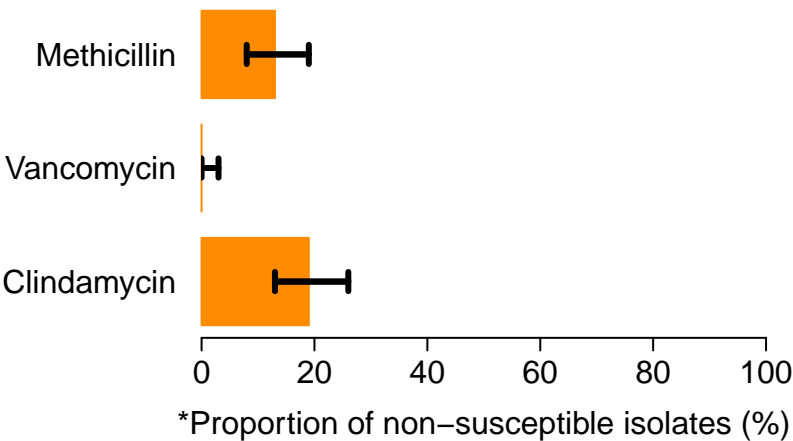
Antibiotic agent	% NS (n)	95% CI
Methicillin	13% (19/148)	8%–19%
Vancomycin	0% (0/148)	0%–3%
Clindamycin	19% (28/148)	13%–26%

**Blood:** *Staphylococcus aureus* **Hospital–origin** *(No. of patients = 57)*

*Proportion of non–susceptible isolates (%)
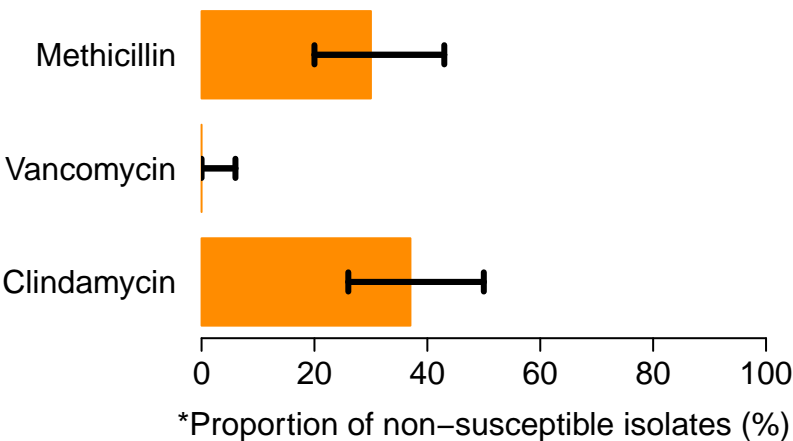
Antibiotic agent	% NS (n)	95% CI
Methicillin	30% (17/57)	20%–43%
Vancomycin	0% (0/57)	0%–6%
Clindamycin	37% (21/57)	26%–50%

*Proportion of non–susceptible isolates (% NS) represents the number of patients with blood culture positive for non–susceptible isolates (numerator) over the total number of patients with blood culture positive for the organism and the organism was tested for susceptibility against the antibiotic (denominator). The AMASS application de–duplicated the data by including only the first isolate per patient per specimen type per evaluation period. Grey bars indicate that testing with the antibiotic occurred for less than 70% of the total number of patients with blood culture positive for the organism.
CI = confidence interval; NA = Not available/reported/tested; Methicillin: methicillin, oxacillin, or cefoxitin

Section [3]: Isolate–based surveillance report with stratification by infection origin
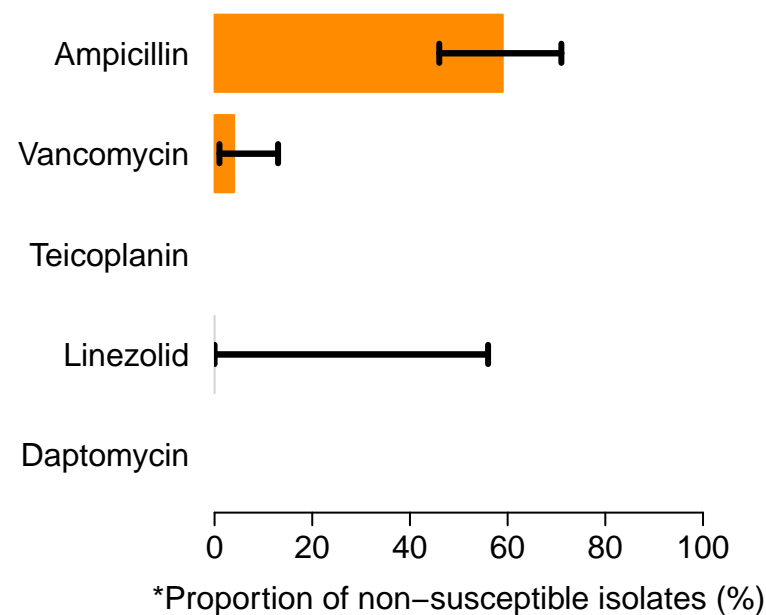
Blood: *Enterococcus* spp.   Community–origin **(No. of patients = 61)**
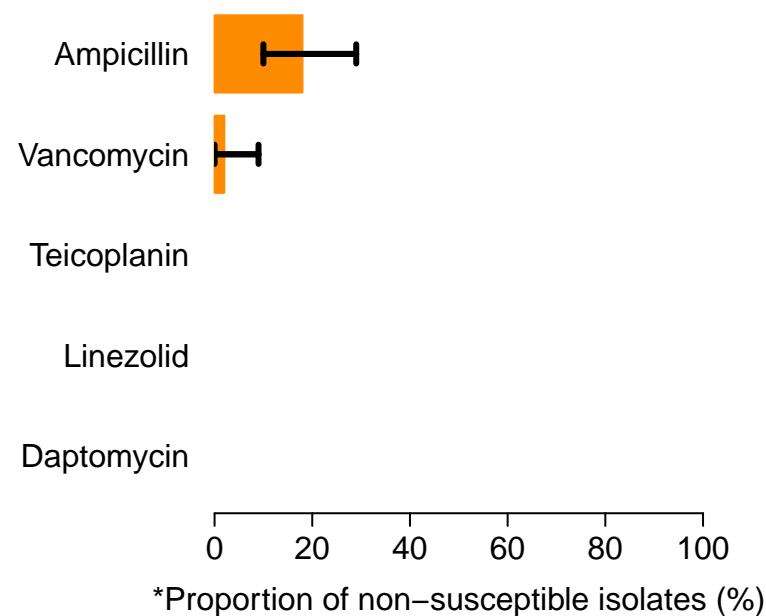
Antibiotic agent	% NS (n)	95% CI
Ampicillin	18% (11/61)	10%–29%
Vancomycin	2% (1/61)	0%–9%
Teicoplanin	NA	–
Linezolid	NA	–
Daptomycin	NA	–

**Blood:** *Enterococcus* spp.   Hospital–origin   **(No. of patients = 54)**

Antibiotic agent	% NS (n)	95% CI
Ampicillin	59% (32/54)	46%–71%
Vancomycin	4% (2/54)	1%–13%
Teicoplanin	NA	–
Linezolid	0% (0/3)	0%–56%
Daptomycin	NA	–

*Proportion of non–susceptible isolates (% NS) represents the number of patients with blood culture positive for non–susceptible isolates (numerator) over the total number of patients with blood culture positive for the organism and the organism was tested for susceptibility against the antibiotic (denominator). The AMASS application de–duplicated the data by including only the first isolate per patient per specimen type per evaluation period. Grey bars indicate that testing with the antibiotic occurred for less than 70% of the total number of patients with blood culture positive for the organism.
CI = confidence interval; NA = Not available/reported/tested; Methicillin: methicillin, oxacillin, or cefoxitin

Section [3]: Isolate–based surveillance report with stratification by infection origin

Blood: *Streptococcus pneumoniae*   Community–origin **(No. of patients = 38)**

*Proportion of non–susceptible isolates (%)
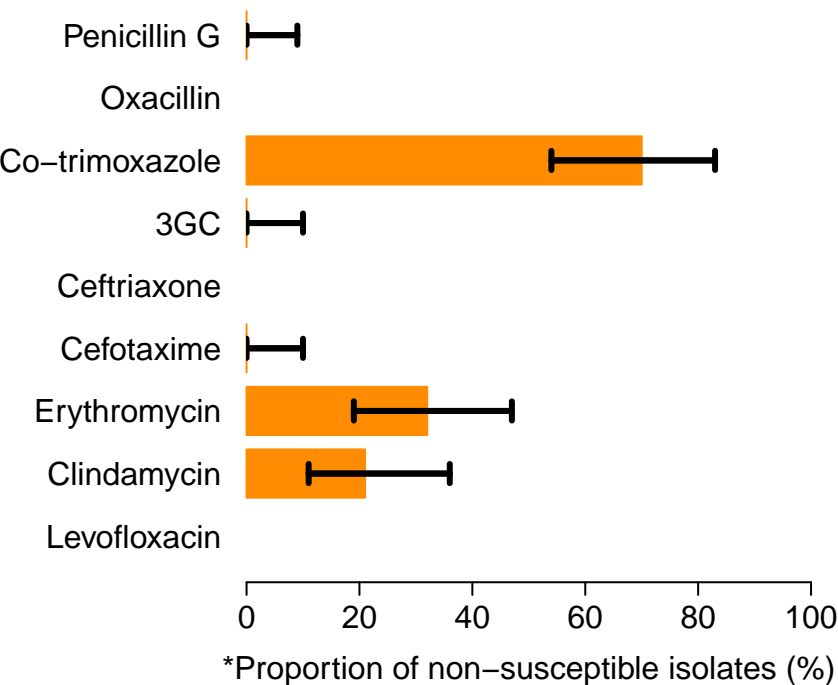
Antibiotic agent	% NS (n)	95% CI
Penicillin G	0% (0/37)	0%–9%
Oxacillin	NA	–
Co–trimoxazole	70% (26/37)	54%–83%
3GC	0% (0/36)	0%–10%
Ceftriaxone	NA	–
Cefotaxime	0% (0/36)	0%–10%
Erythromycin	32% (12/38)	19%–47%
Clindamycin	21% (8/38)	11%–36%
Levofloxacin	NA	–

**Blood:** *Streptococcus pneumoniae*   Hospital–origin   **(No. of patients = 4)**

*Proportion of non–susceptible isolates (%)
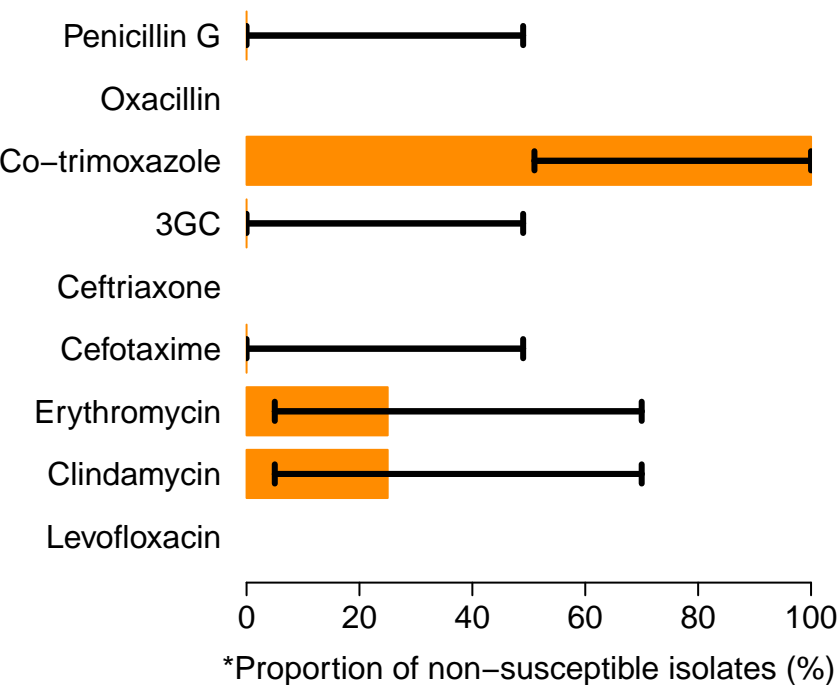
Antibiotic agent	% NS (n)	95% CI
Penicillin G	0% (0/4)	0%–49%
Oxacillin	NA	–
Co–trimoxazole	100% (4/4)	51%–100%
3GC	0% (0/4)	0%–49%
Ceftriaxone	NA	–
Cefotaxime	0% (0/4)	0%–49%
Erythromycin	25% (1/4)	5%–70%
Clindamycin	25% (1/4)	5%–70%
Levofloxacin	NA	–

*Proportion of non–susceptible isolates (% NS) represents the number of patients with blood culture positive for non–susceptible isolates (numerator) over the total number of patients with blood culture positive for the organism and the organism was tested for susceptibility against the antibiotic (denominator). The AMASS application de–duplicated the data by including only the first isolate per patient per specimen type per evaluation period. Grey bars indicate that testing with the antibiotic occurred for less than 70% of the total number of blood culture positive for the organism.

CI = confidence interval; NA = Not available/reported/tested; 3GC = 3rd–generation cephalosporin; FLUOROQUINOLONES: ciprofloxacin or levofloxacin; CARBAPENEMS: imipenem, meropenem, ertapenem or doripenem

Section [3]: Isolate–based surveillance report with stratification by infection origin
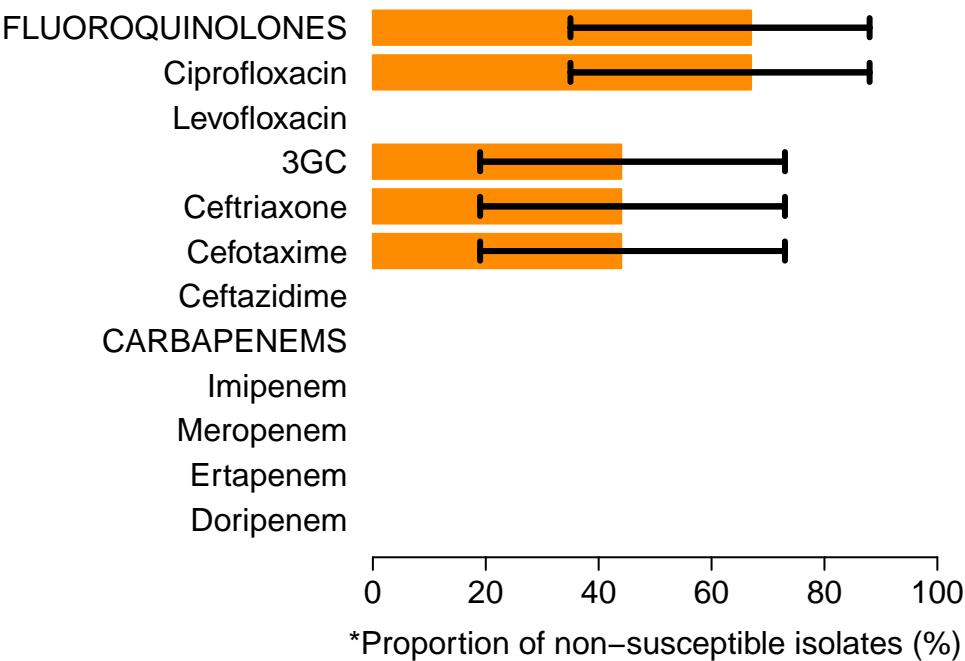
Blood: *Salmonella* spp.

Community–origin (No. of patients = 52)

*Proportion of non–susceptible isolates (%)
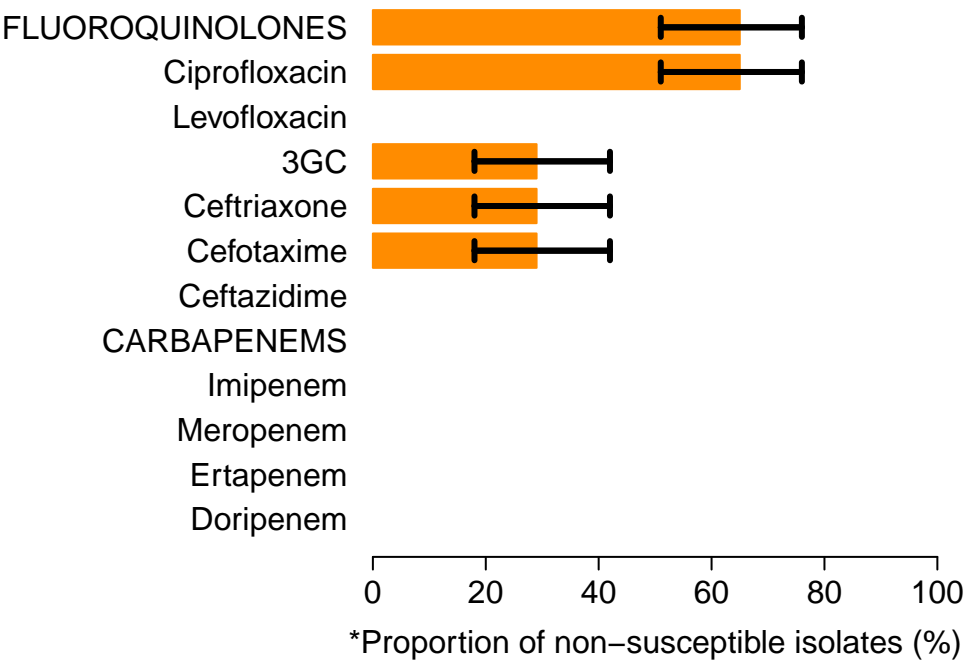
Antibiotic agent	% NS (n)	95% CI
FLUOROQUINOLONES	65% (33/51)	51%–76%
Ciprofloxacin	65% (33/51)	51%–76%
Levofloxacin	NA	–
3GC	29% (15/52)	18%–42%
Ceftriaxone	29% (15/52)	18%–42%
Cefotaxime	29% (15/52)	18%–42%
Ceftazidime	NA	–
CARBAPENEMS	NA	–
Imipenem	NA	–
Meropenem	NA	–
Ertapenem	NA	–
Doripenem	NA	–

Blood: *Salmonella* spp.

Hospital–origin (No. of patients = 9)

*Proportion of non–susceptible isolates (%)

Antibiotic agent	% NS (n)	95% CI
FLUOROQUINOLONES	67% (6/9)	35%–88%
Ciprofloxacin	67% (6/9)	35%–88%
Levofloxacin	NA	–
3GC	44% (4/9)	19%–73%
Ceftriaxone	44% (4/9)	19%–73%
Cefotaxime	44% (4/9)	19%–73%
Ceftazidime	NA	–
CARBAPENEMS	NA	–
Imipenem	NA	–
Meropenem	NA	–
Ertapenem	NA	–
Doripenem	NA	–

*Proportion of non–susceptible isolates (% NS) represents the number of patients with blood culture positive for non–susceptible isolates (numerator) over the total number of patients with blood culture positive for the organism and the organism was tested for susceptibility against the antibiotic (denominator). The AMASS application de–duplicated the data by including only the first isolate per patient per specimen type per evaluation period. Grey bars indicate that testing with the antibiotic occurred for less than 70% of the total number of blood culture positive for the organism.

CI = confidence interval; NA = Not available/reported/tested; 3GC = 3rd–generation cephalosporin;
FLUOROQUINOLONES: ciprofloxacin or levofloxacin; CARBAPENEMS: imipenem, meropenem, ertapenem or doripenem

Section [3]: Isolate–based surveillance report with stratification by infection origin

Blood: *Escherichia coli*

Community–origin *(No. of patients = 400)*

*Proportion of non–susceptible isolates (%)
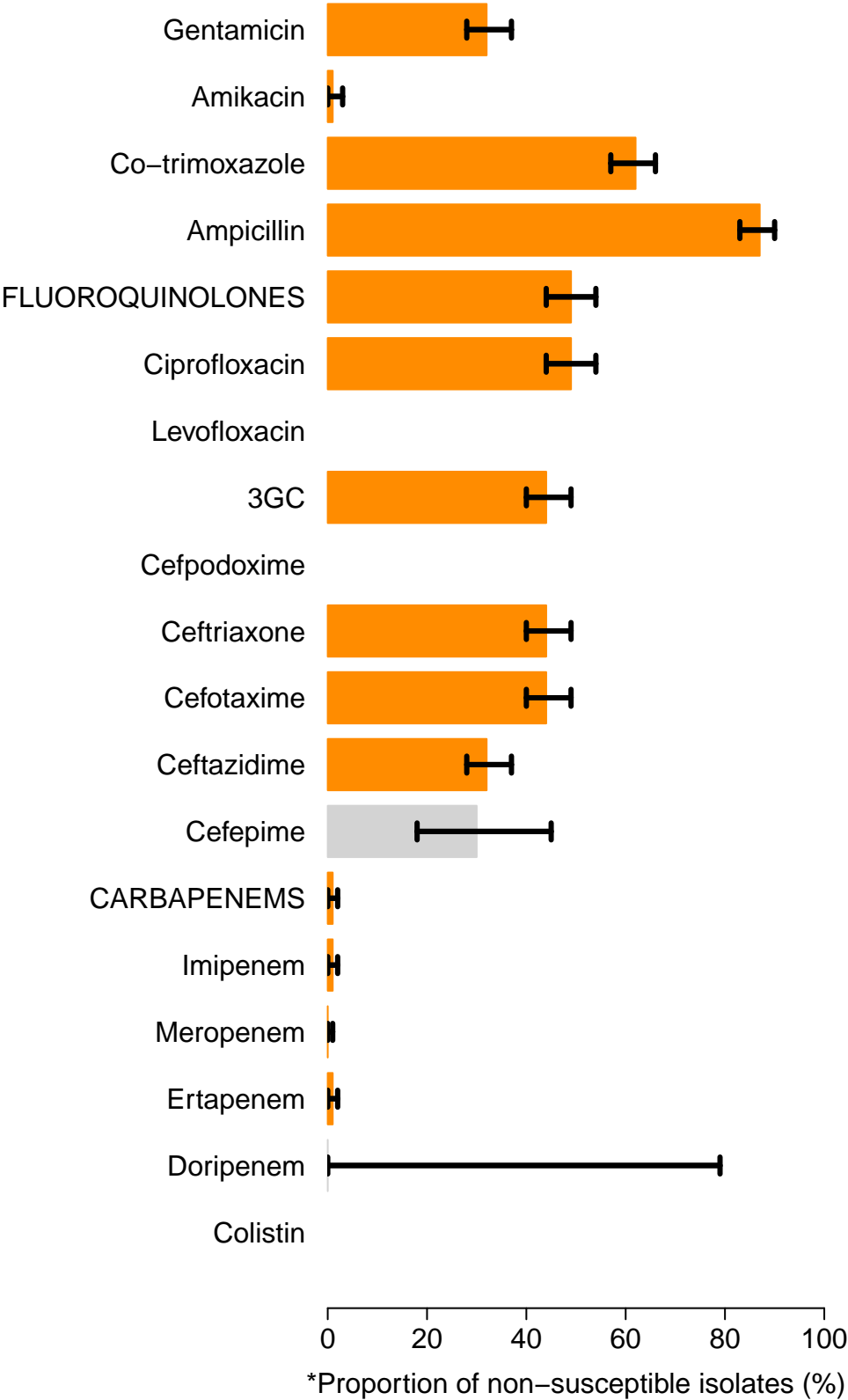
Antibiotic agent	% NS (n)	95% CI
Gentamicin	32% (129/398)	28%–37%
Amikacin	1% (4/400)	0%–3%
Co–trimoxazole	62% (247/400)	57%–66%
Ampicillin	87% (347/400)	83%–90%
FLUOROQUINOLONES	49% (191/392)	44%–54%
Ciprofloxacin	49% (191/392)	44%–54%
Levofloxacin	NA	–
3GC	44% (178/400)	40%–49%
Cefpodoxime	NA	–
Ceftriaxone	44% (178/400)	40%–49%
Cefotaxime	44% (178/400)	40%–49%
Ceftazidime	32% (125/387)	28%–37%
Cefepime	30% (12/40)	18%–45%
CARBAPENEMS	1% (2/399)	0%–2%
Imipenem	1% (2/399)	0%–2%
Meropenem	0% (0/314)	0%–1%
Ertapenem	1% (2/398)	0%–2%
Doripenem	0% (0/1)	0%–79%
Colistin	NA	–

*Proportion of non–susceptible isolates (% NS) represents the number of patients with blood culture positive for non–susceptible isolates (numerator) over the total number of patients with blood culture positive for the organism and the organism was tested for susceptibility against the antibiotic (denominator). The AMASS application de–duplicated the data by including only the first isolate per patient per specimen type per evaluation period. Grey bars indicate that testing with the antibiotic occurred for less than 70% of the total number of blood culture positive for the organism.

CI = confidence interval; NA = Not available/reported/tested; 3GC = 3rd–generation cephalosporin; FLUOROQUINOLONES: ciprofloxacin or levofloxacin; CARBAPENEMS: imipenem, meropenem, ertapenem or doripenem

Section [3]: Isolate–based surveillance report with stratification by infection origin

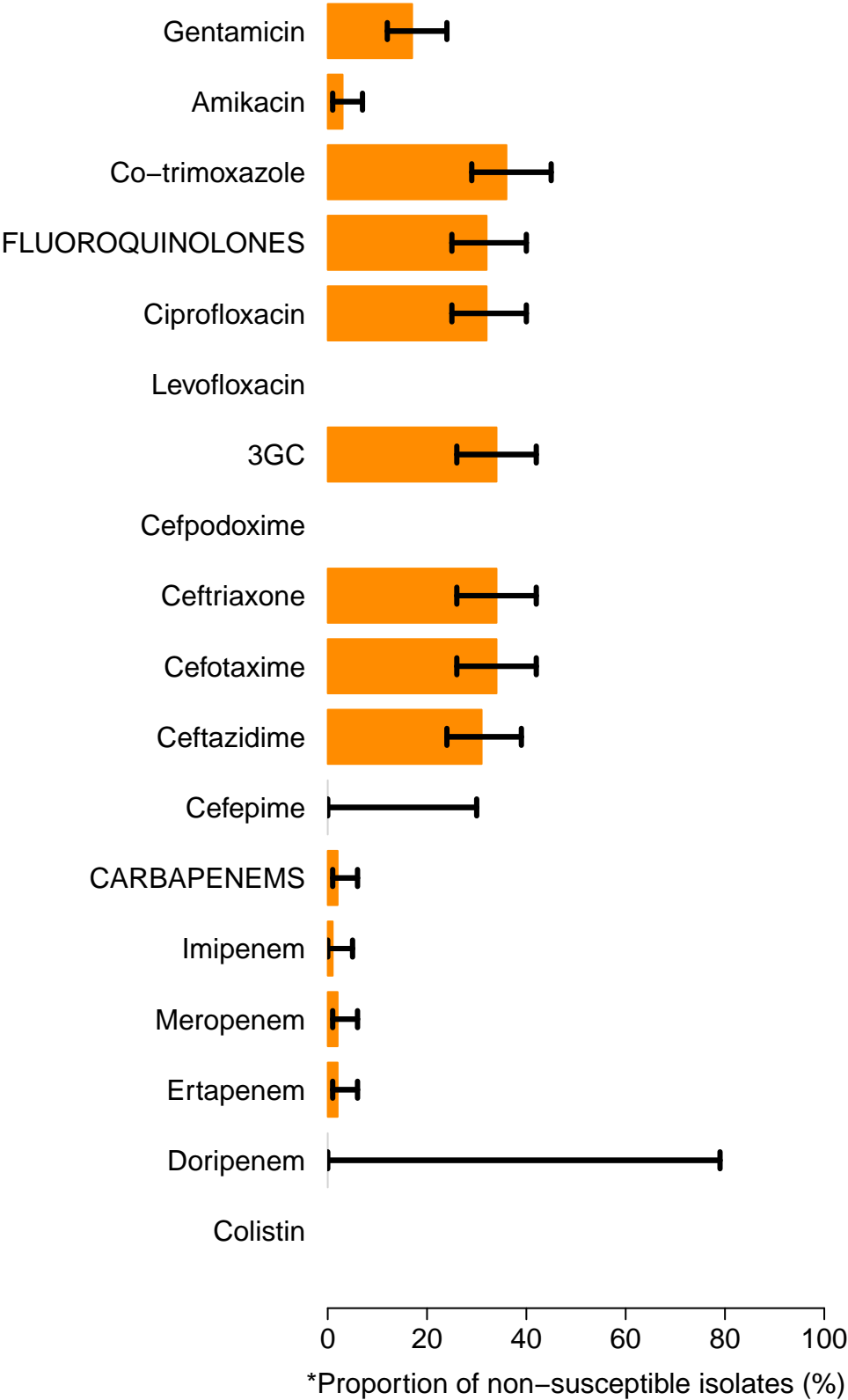**Blood:** *Escherichia coli*   **Hospital–origin**   *(No. of patients = 110)*
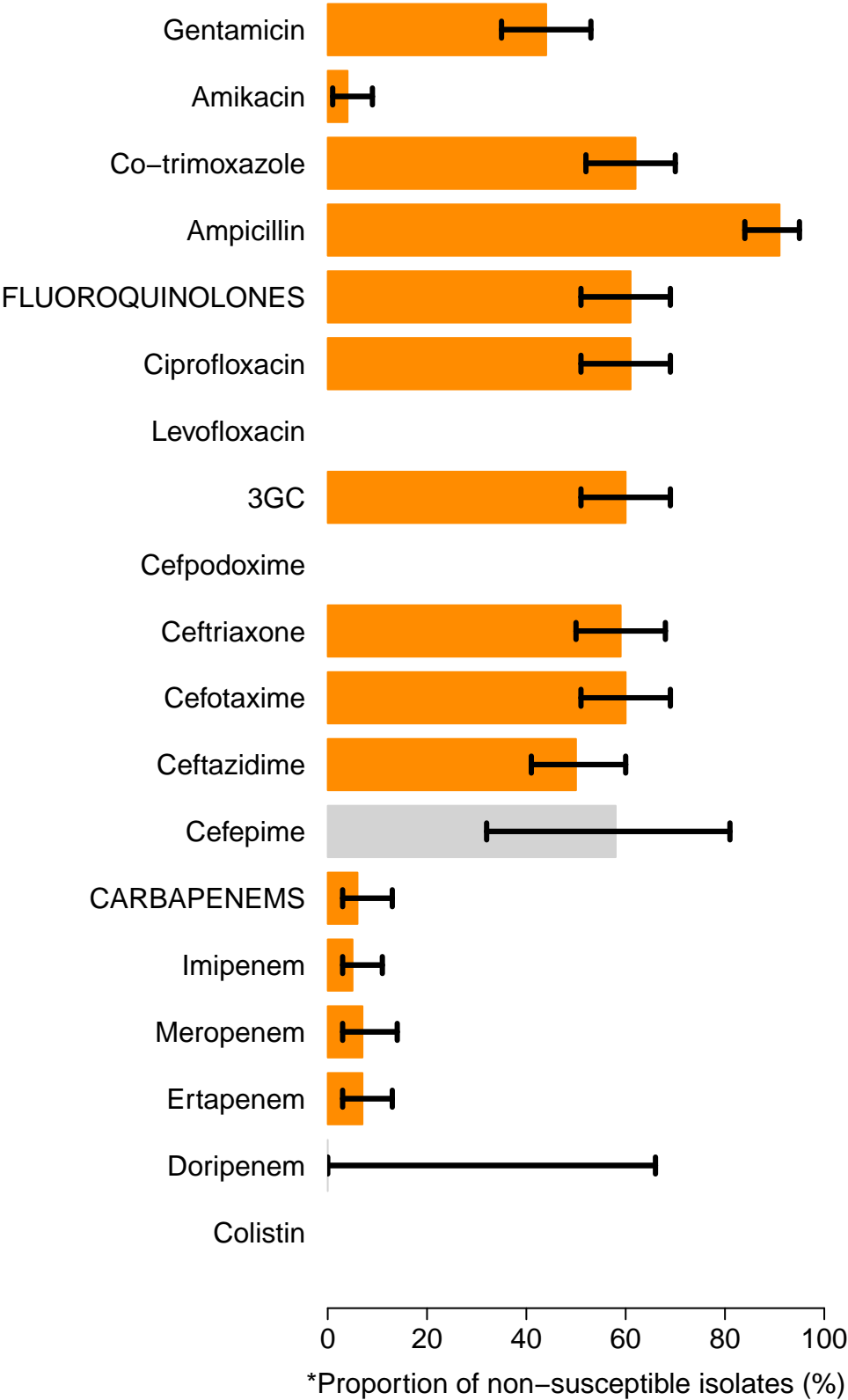
Antibiotic agent	% NS (n)	95% CI
Gentamicin	44% (48/110)	35%–53%
Amikacin	4% (4/110)	1%–9%
Co–trimoxazole	62% (68/110)	52%–70%
Ampicillin	91% (100/110)	84%–95%
FLUOROQUINOLONES	61% (66/109)	51%–69%
Ciprofloxacin	61% (66/109)	51%–69%
Levofloxacin	NA	–
3GC	60% (66/110)	51%–69%
Cefpodoxime	NA	–
Ceftriaxone	59% (65/110)	50%–68%
Cefotaxime	60% (66/110)	51%–69%
Ceftazidime	50% (53/105)	41%–60%
Cefepime	58% (7/12)	32%–81%
CARBAPENEMS	6% (7/110)	3%–13%
Imipenem	5% (6/110)	3%–11%
Meropenem	7% (6/92)	3%–14%
Ertapenem	7% (7/106)	3%–13%
Doripenem	0% (0/2)	0%–66%
Colistin	NA	–

*Proportion of non–susceptible isolates (%)

*Proportion of non–susceptible isolates (% NS) represents the number of patients with blood culture positive for non–susceptible isolates (numerator) over the total number of patients with blood culture positive for the organism and the organism was tested for susceptibility against the antibiotic (denominator). The AMASS application de–duplicated the data by including only the first isolate per patient per specimen type per evaluation period. Grey bars indicate that testing with the antibiotic occurred for less than 70% of the total number of blood culture positive for the organism.

CI = confidence interval; NA = Not available/reported/tested; 3GC = 3rd–generation cephalosporin; FLUOROQUINOLONES: ciprofloxacin or levofloxacin; CARBAPENEMS: imipenem, meropenem, ertapenem or doripenem

Section [3]: Isolate–based surveillance report with stratification by infection origin

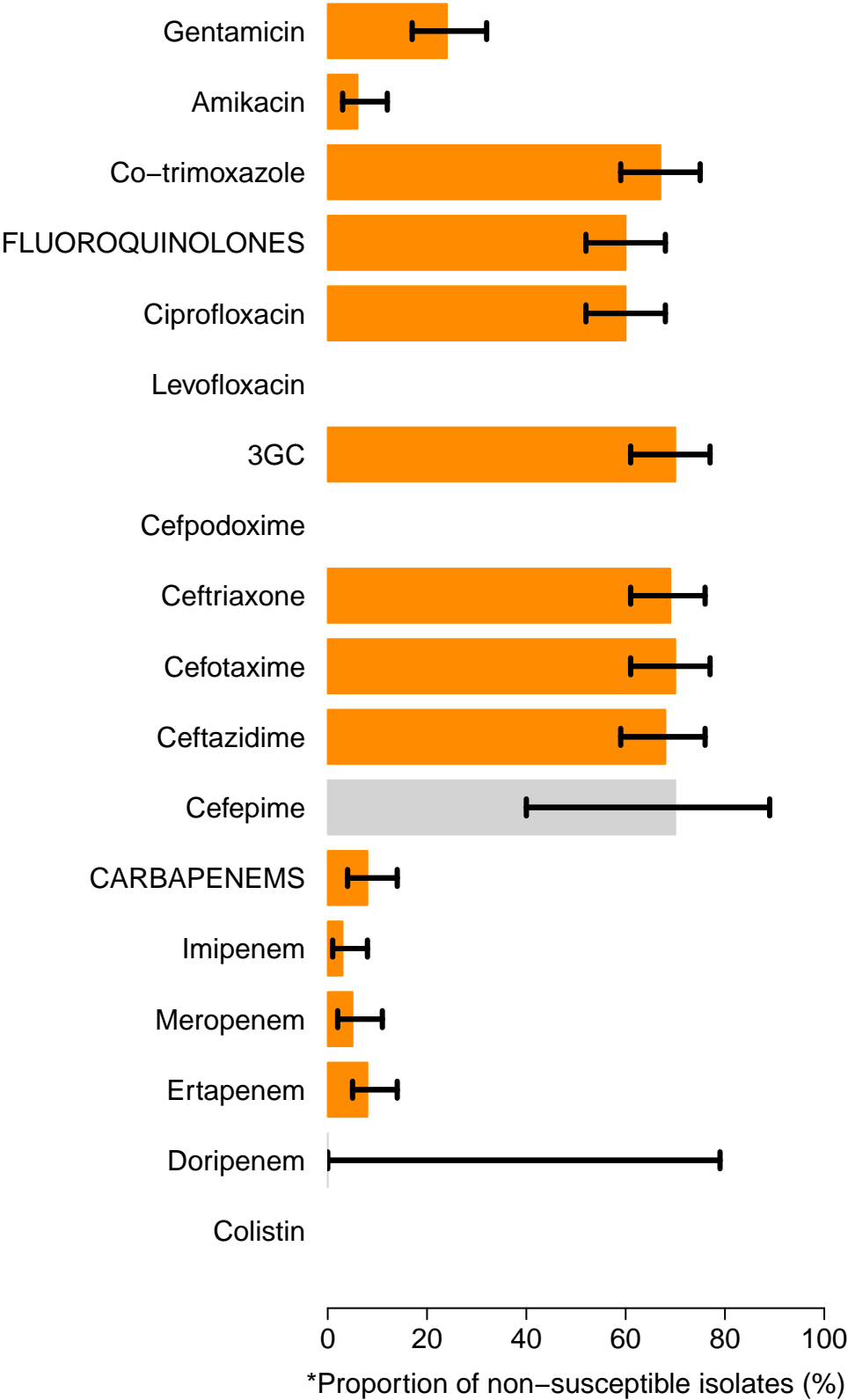**Blood:** *Klebsiella pneumoniae*   **Community–origin** *(No. of patients = 140)*

Antibiotic agent	% NS (n)	95% CI
Gentamicin	17% (24/140)	12%–24%
Amikacin	3% (4/140)	1%–7%
Co–trimoxazole	36% (51/140)	29%–45%
FLUOROQUINOLONES	32% (44/137)	25%–40%
Ciprofloxacin	32% (44/137)	25%–40%
Levofloxacin	NA	–
3GC	34% (47/140)	26%–42%
Cefpodoxime	NA	–
Ceftriaxone	34% (47/140)	26%–42%
Cefotaxime	34% (47/140)	26%–42%
Ceftazidime	31% (43/138)	24%–39%
Cefepime	0% (0/9)	0%–30%
CARBAPENEMS	2% (3/140)	1%–6%
Imipenem	1% (2/140)	0%–5%
Meropenem	2% (2/110)	1%–6%
Ertapenem	2% (3/140)	1%–6%
Doripenem	0% (0/1)	0%–79%
Colistin	NA	–

*Proportion of non–susceptible isolates (%)

*Proportion of non–susceptible isolates (% NS) represents the number of patients with blood culture positive for non–susceptible isolates (numerator) over the total number of patients with blood culture positive for the organism and the organism was tested for susceptibility against the antibiotic (denominator). The AMASS application de–duplicated the data by including only the first isolate per patient per specimen type per evaluation period. Grey bars indicate that testing with the antibiotic occurred for less than 70% of the total number of blood culture positive for the organism.
CI = confidence interval; NA = Not available/reported/tested; 3GC = 3rd–generation cephalosporin;
FLUOROQUINOLONES: ciprofloxacin or levofloxacin; CARBAPENEMS: imipenem, meropenem, ertapenem or doripenem

Section [3]: Isolate–based surveillance report with stratification by infection origin

Blood: *Klebsiella pneumoniae*   **Hospital–origin**   *(No. of patients = 126)*

Antibiotic agent	% NS (n)	95% CI
Gentamicin	24% (30/126)	17%–32%
Amikacin	6% (8/126)	3%–12%
Co–trimoxazole	67% (85/126)	59%–75%
FLUOROQUINOLONES	60% (76/126)	52%–68%
Ciprofloxacin	60% (76/126)	52%–68%
Levofloxacin	NA	–
3GC	70% (88/126)	61%–77%
Cefpodoxime	NA	–
Ceftriaxone	69% (87/126)	61%–76%
Cefotaxime	70% (88/126)	61%–77%
Ceftazidime	68% (85/125)	59%–76%
Cefepime	70% (7/10)	40%–89%
CARBAPENEMS	8% (10/126)	4%–14%
Imipenem	3% (4/126)	1%–8%
Meropenem	5% (5/102)	2%–11%
Ertapenem	8% (10/122)	5%–14%
Doripenem	0% (0/1)	0%–79%
Colistin	NA	–

*Proportion of non–susceptible isolates (%)

*Proportion of non–susceptible isolates (% NS) represents the number of patients with blood culture positive for non–susceptible isolates (numerator) over the total number of patients with blood culture positive for the organism and the organism was tested for susceptibility against the antibiotic (denominator). The AMASS application de–duplicated the data by including only the first isolate per patient per specimen type per evaluation period. Grey bars indicate that testing with the antibiotic occurred for less than 70% of the total number of blood culture positive for the organism.

CI = confidence interval; NA = Not available/reported/tested; 3GC = 3rd–generation cephalosporin;
FLUOROQUINOLONES: ciprofloxacin or levofloxacin; CARBAPENEMS: imipenem, meropenem, ertapenem or doripenem

Section [3]: Isolate–based surveillance report with stratification by infection origin

Blood: *Pseudomonas aeruginosa*   Community–origin *(No. of patients = 35)*
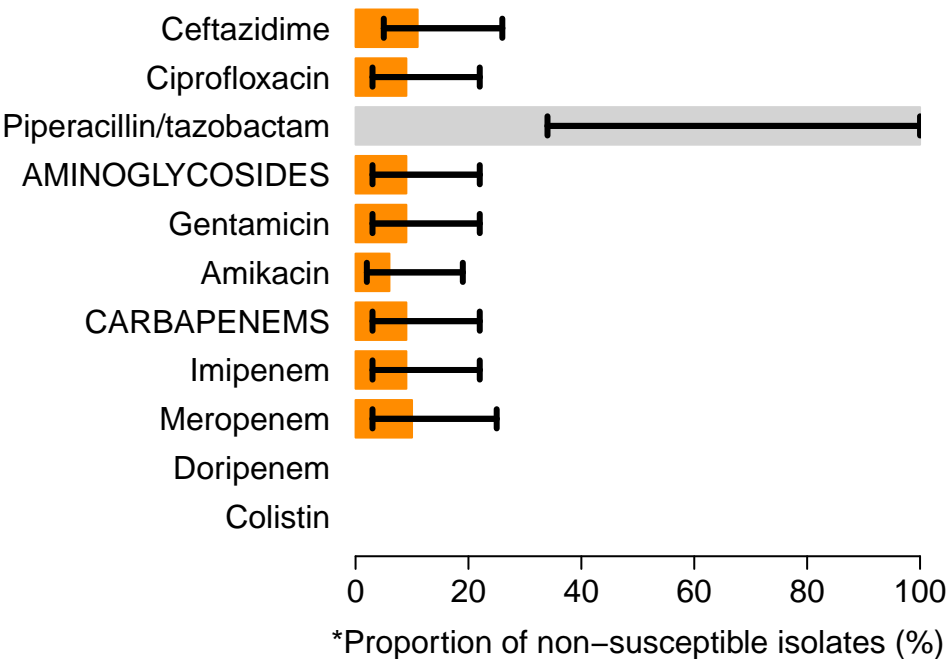
Antibiotic agent	% NS (n)	95% CI
Ceftazidime	11% (4/35)	5%–26%
Ciprofloxacin	9% (3/35)	3%–22%
Piperacillin/tazobactam	100% (2/2)	34%–100%
AMINOGLYCOSIDES	9% (3/35)	3%–22%
Gentamicin	9% (3/35)	3%–22%
Amikacin	6% (2/35)	2%–19%
CARBAPENEMS	9% (3/35)	3%–22%
Imipenem	9% (3/35)	3%–22%
Meropenem	10% (3/31)	3%–25%
Doripenem	NA	–
Colistin	NA	–

**Blood:** *Pseudomonas aeruginosa*   Hospital–origin *(No. of patients = 74)*
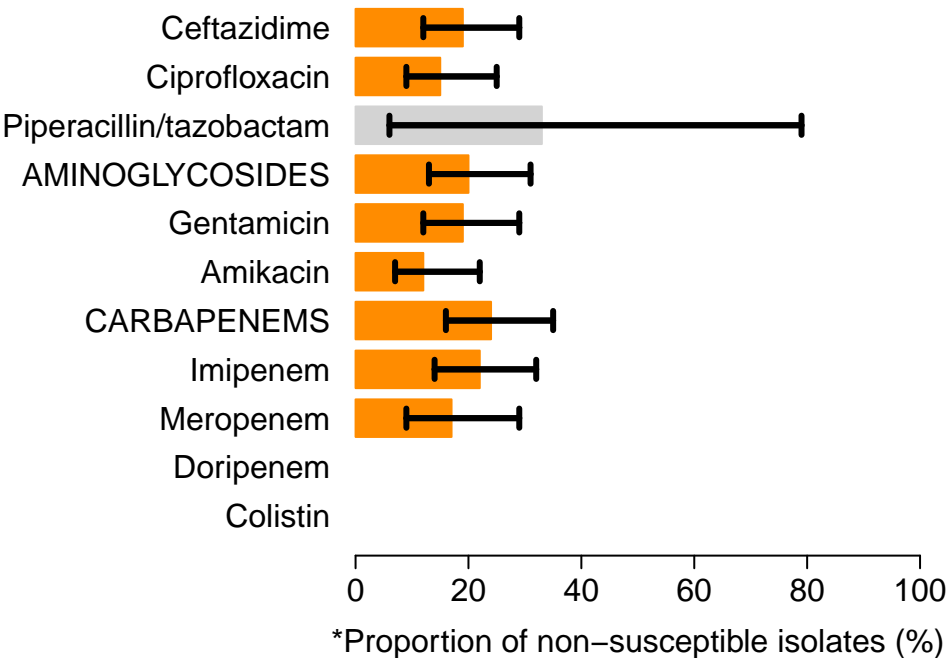
Antibiotic agent	% NS (n)	95% CI
Ceftazidime	19% (14/74)	12%–29%
Ciprofloxacin	15% (11/74)	9%–25%
Piperacillin/tazobactam	33% (1/3)	6%–79%
AMINOGLYCOSIDES	20% (15/74)	13%–31%
Gentamicin	19% (14/74)	12%–29%
Amikacin	12% (9/74)	7%–22%
CARBAPENEMS	24% (18/74)	16%–35%
Imipenem	22% (16/74)	14%–32%
Meropenem	17% (9/53)	9%–29%
Doripenem	NA	–
Colistin	NA	–

*Proportion of non–susceptible isolates (% NS) represents the number of patients with blood culture positive for non–susceptible isolates (numerator) over the total number of patients with blood culture positive for the organism and the organism was tested for susceptibility against the antibiotic (denominator). The AMASS application de–duplicated the data by including only the first isolate per patient per specimen type per evaluation period. Grey bars indicate that testing with the antibiotic occurred for less than 70% of the total number of blood culture positive for the organism.
CI = confidence interval; NA = Not available/reported/tested; AMINOGLYCOSIDES: either gentamicin or amikacin; CARBAPENEMS: imipenem, meropenem, ertapenem or doripenem

Section [3]: Isolate–based surveillance report with stratification by infection origin
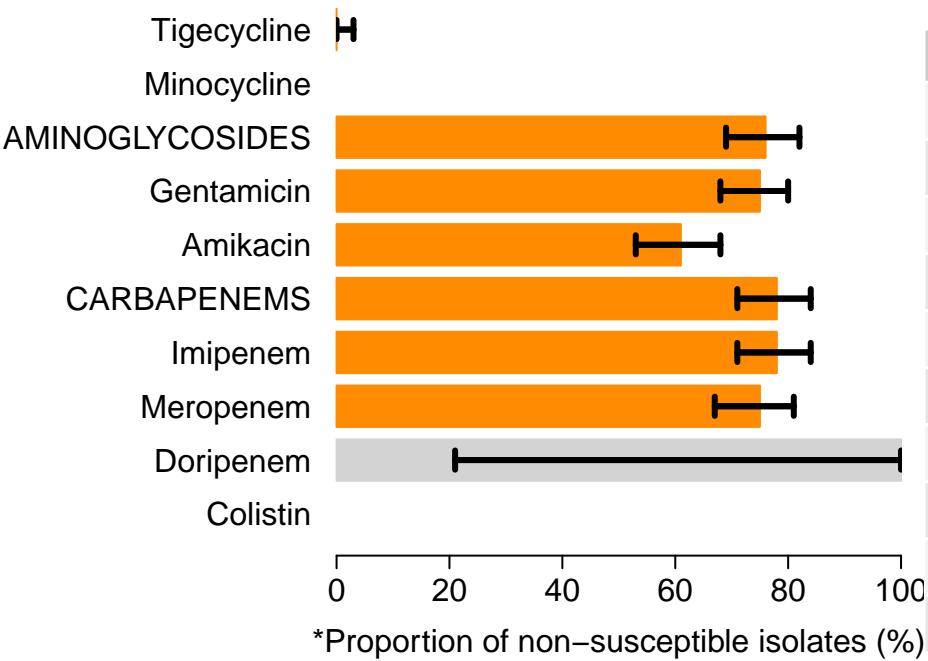
Blood: *Acinetobacter* spp. Community–origin *(No. of patients = 62)*

*Proportion of non–susceptible isolates (%)
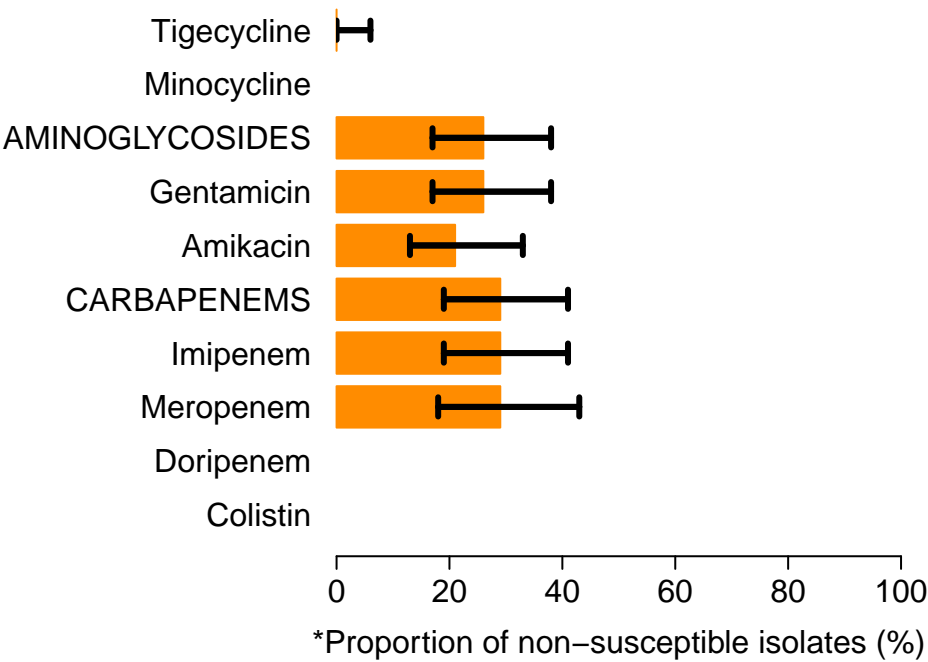
Antibiotic agent	% NS (n)	95% CI
Tigecycline	0% (0/59)	0%–6%
Minocycline	NA	–
AMINOGLYCOSIDES	26% (16/62)	17%–38%
Gentamicin	26% (16/62)	17%–38%
Amikacin	21% (13/62)	13%–33%
CARBAPENEMS	29% (18/62)	19%–41%
Imipenem	29% (18/62)	19%–41%
Meropenem	29% (14/48)	18%–43%
Doripenem	NA	–
Colistin	NA	–

Blood: *Acinetobacter* spp. Hospital–origin *(No. of patients = 173)*

*Proportion of non–susceptible isolates (%)

Antibiotic agent	% NS (n)	95% CI
Tigecycline	0% (0/140)	0%–3%
Minocycline	NA	–
AMINOGLYCOSIDES	76% (131/173)	69%–82%
Gentamicin	75% (129/173)	68%–80%
Amikacin	61% (105/173)	53%–68%
CARBAPENEMS	78% (135/173)	71%–84%
Imipenem	78% (135/173)	71%–84%
Meropenem	75% (103/138)	67%–81%
Doripenem	100% (1/1)	21%–100%
Colistin	NA	–

*Proportion of non–susceptible isolates (% NS) represents the number of patients with blood culture positive for non–susceptible isolates (numerator) over the total number of patients with blood culture positive for the organism and the organism was tested for susceptibility against the antibiotic (denominator). The AMASS application de–duplicated the data by including only the first isolate per patient per specimen type per evaluation period. Grey bars indicate that testing with the antibiotic occurred for less than 70% of the total number of blood culture positive for the organism.
CI = confidence interval; NA = Not available/reported/tested; AMINOGLYCOSIDES: either gentamicin or amikacin; CARBAPENEMS: imipenem, meropenem, ertapenem or doripenem

Section [4]: Sample–based surveillance report

Introduction

A sample–based surveillance report is generated if data of culture negative is available.

The sample–based approach involves the collection of data on all blood samples taken for microbiological testing and includes information on the number of positive blood samples for a specific specimen type (both pathogens under the survey and other bacteria) as well as number of negative (no microbial growth) samples. After removal of duplicate results and assuming that routine blood culture testing is applied systematically, we can use the number of tested patients as a proxy for a number of patients with new cases of bloodstream infection (BSI).

Results:

The microbiology_data file had:

Specimen collection dates ranged from   ***01 Jan 2015 to 31 Dec 2015***
Number of records on blood specimen collected within the above date range:
56316 blood specimen records
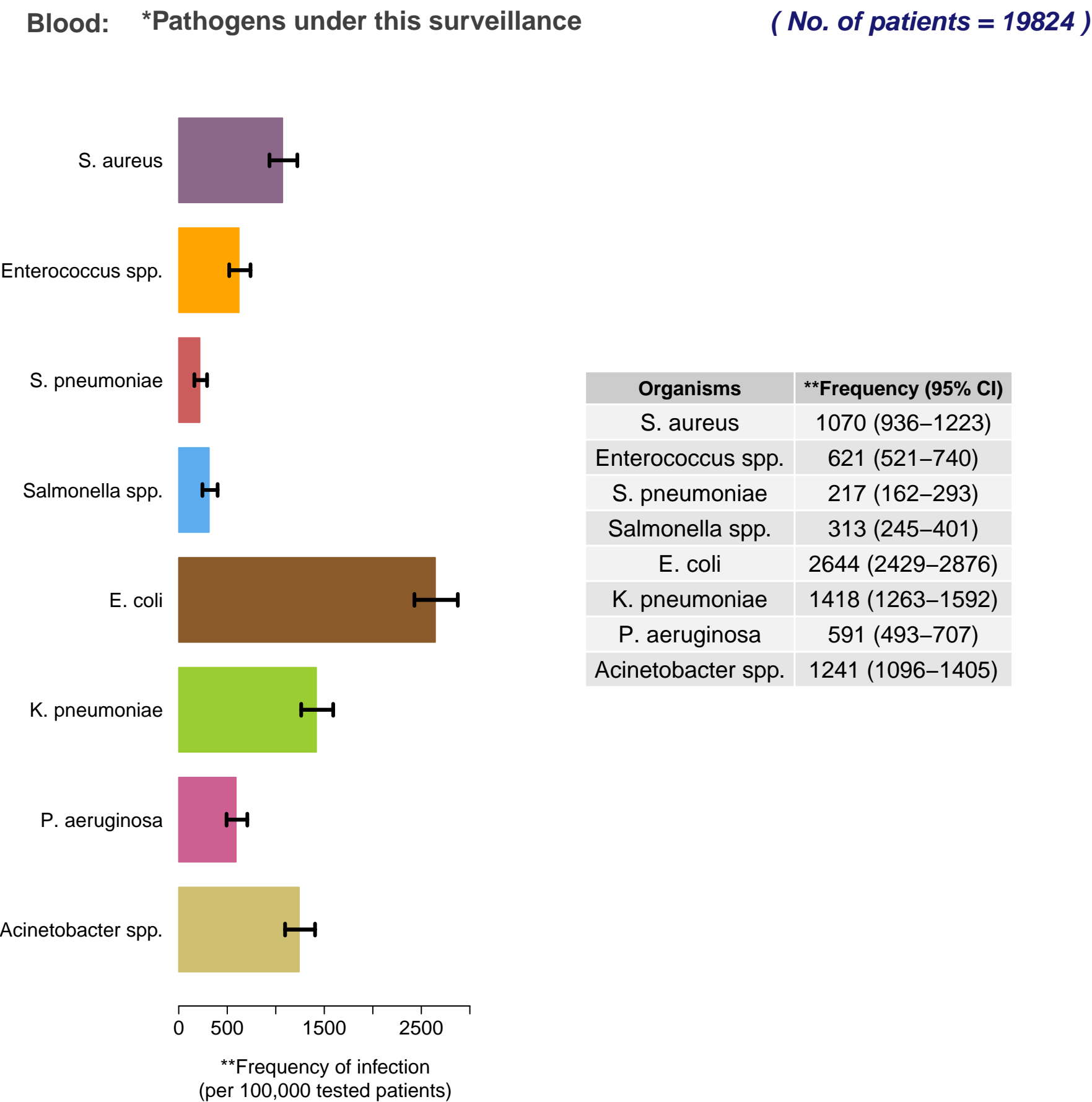**Number of patients sampled for blood culture within the above date range:*
19824 patients sampled for blood culture

Note:

*Number of patients sampled for blood culture is used as denominator to estimate the frequency of infections per 100,000 tested patients

The following figures show the frequncy of infections for patients with blood culture tested.

Section [4]: Sample–based surveillance report

Blood: ***Pathogens under this surveillance**   *(No. of patients = 19824)*

Organisms	**Frequency (95% CI)
S. aureus	1070 (936–1223)
Enterococcus spp.	621 (521–740)
S. pneumoniae	217 (162–293)
Salmonella spp.	313 (245–401)
E. coli	2644 (2429–2876)
K. pneumoniae	1418 (1263–1592)
P. aeruginosa	591 (493–707)
Acinetobacter spp.	1241 (1096–1405)

*We apologise that the bacteria name in the table and in the figure are not written in italic. This is because of the R command we used. We will improve this in the next version.

**Frequency of infection per 100,000 tested patients represents the number of patients with blood culture positive for a pathogen (numerator) over the total number of tested patients (denominator). The AMASS application de–duplicates the data by included only the first isolate of each patient per specimen type per reporting period.

CI = confidence interval; NS = non–susceptible; NA = Not available/reported/tested; 3GC = 3rd–generation cephalosporin

Section [4]: Sample–based surveillance report

Blood: *AMR pathogens under this surveillance   *(No. of patients = 19824)*
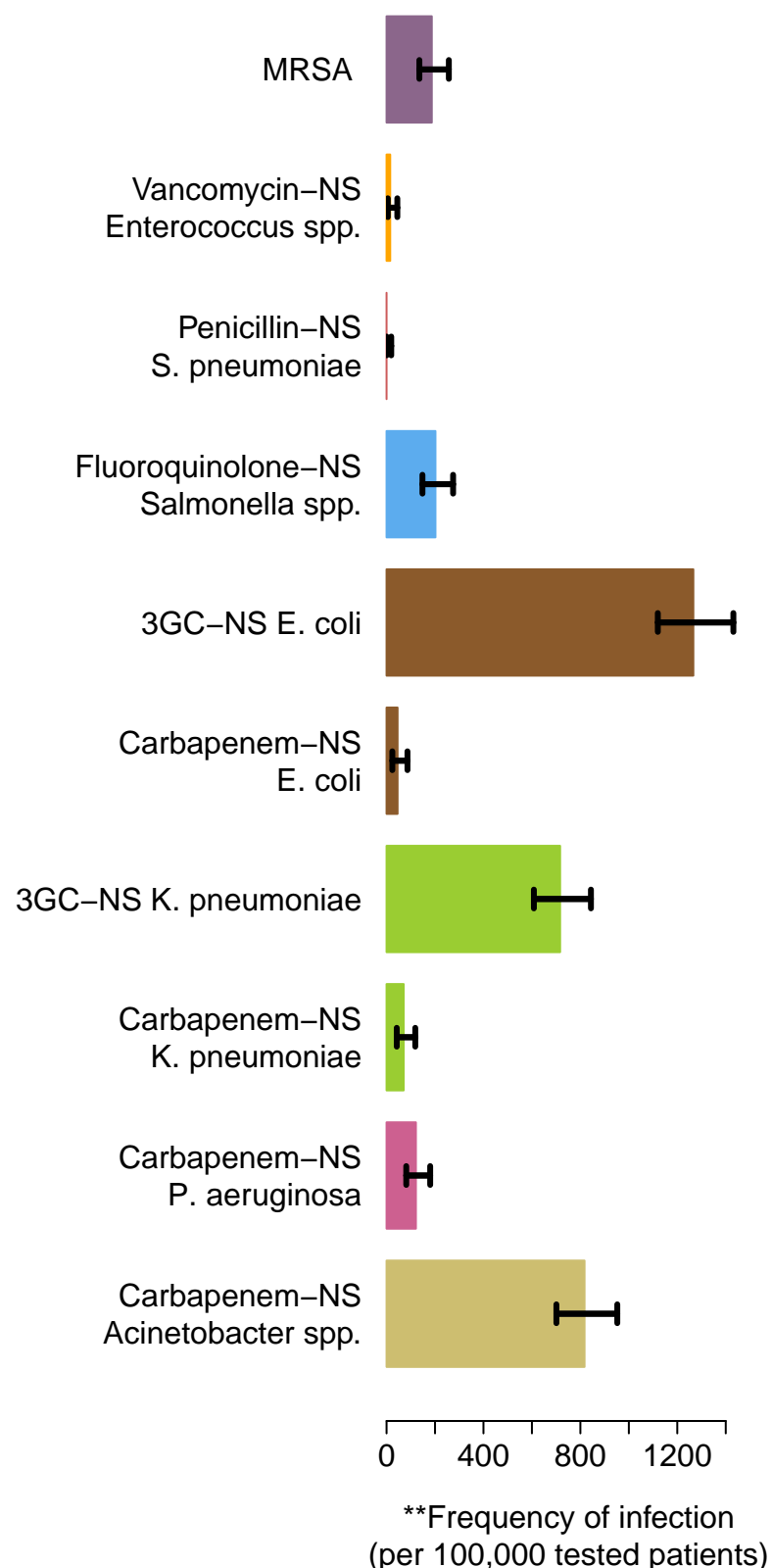
Organism	**Frequency (95% CI)
MRSA	187 (136–258)
Vancomycin–NS Enterococcus spp.	16 (6–45)
Penicillin–NS S. pneumoniae	0 (0–20)
Fluoroquinolone–NS Salmonella spp.	202 (149–275)
3GC–NS E. coli	1267 (1120–1432)
Carbapenem–NS E. coli	46 (24–87)
3GC–NS K. pneumoniae	717 (609–844)
Carbapenem–NS K. pneumoniae	71 (43–119)
Carbapenem–NS P. aeruginosa	122 (82–181)
Carbapenem–NS Acinetobacter spp.	818 (702–953)

**Frequency of infection
(per 100,000 tested patients)

*We apologise that the bacteria name in the table and in the figure are not written in italic. This is because of the R command we used. We will improve this in the next version.

**Frequency of infection per 100,000 tested patients represents the number of patients with blood culture positive for a pathogen (numerator) over the total number of tested patients (denominator). The AMASS application de–duplicates the data by included only the first isolate of each patient per specimen type per reporting period.

CI = confidence interval; NS = non–susceptible; NA = Not available/reported/tested; 3GC = 3rd–generation cephalosporin

Section [5]: Sample–based surveillance report with stratification by infection origin

Introduction

A sample–based surveillance report with stratification by origin of infection is generated only if data of culture negative is available and admission date or a variable containing the classification is available in the raw data file with the appropriate specification in the data dictionaries.

Results:

The data included in the analysis had:

Specimen collection dates ranged from *01 Jan 2015 to 31 Dec 2015*

Number of records on blood specimen collected within the above date range:

56316 blood specimen records

Number of patients sampled for blood culture within the above date range:

19824 patients sampled for blood culture

16079 patients had at least one admission having the first blood culture drawn within first 2 calendar days of hospital admission.

This parameter is used as a denominators for frequency of community–origin bacteraemia (per 100,000 patients tested for blood culture on admission).

4116 patients had at least one admission having the first blood culture drawn after 2 calendar days of hospital admission.

This parameter is used as a denominators for frequency of hospital–origin bacteraemia (per 100,000 patients tested for blood culture for HAI).

394 patients had a blood drawn for culture and with unknown origin of infection. Validation of this statistics is highly recommended.

Note:

765 patients had more than one admissions, of which at least one admission had the first blood culture drawn within the first 2 calendar days of hospital admission AND at least one admission had the first blood culture drawn after 2 calendar days of hospital admission.

The following figures show the frequency of infections for patients with blood culture tested and stratified by infection origin, under this surveillance.

Section [5]: Sample–based surveillance report with stratification by infection origin

Blood: ***Pathogens**   **Community–origin** *(No. of patients = 16079)*
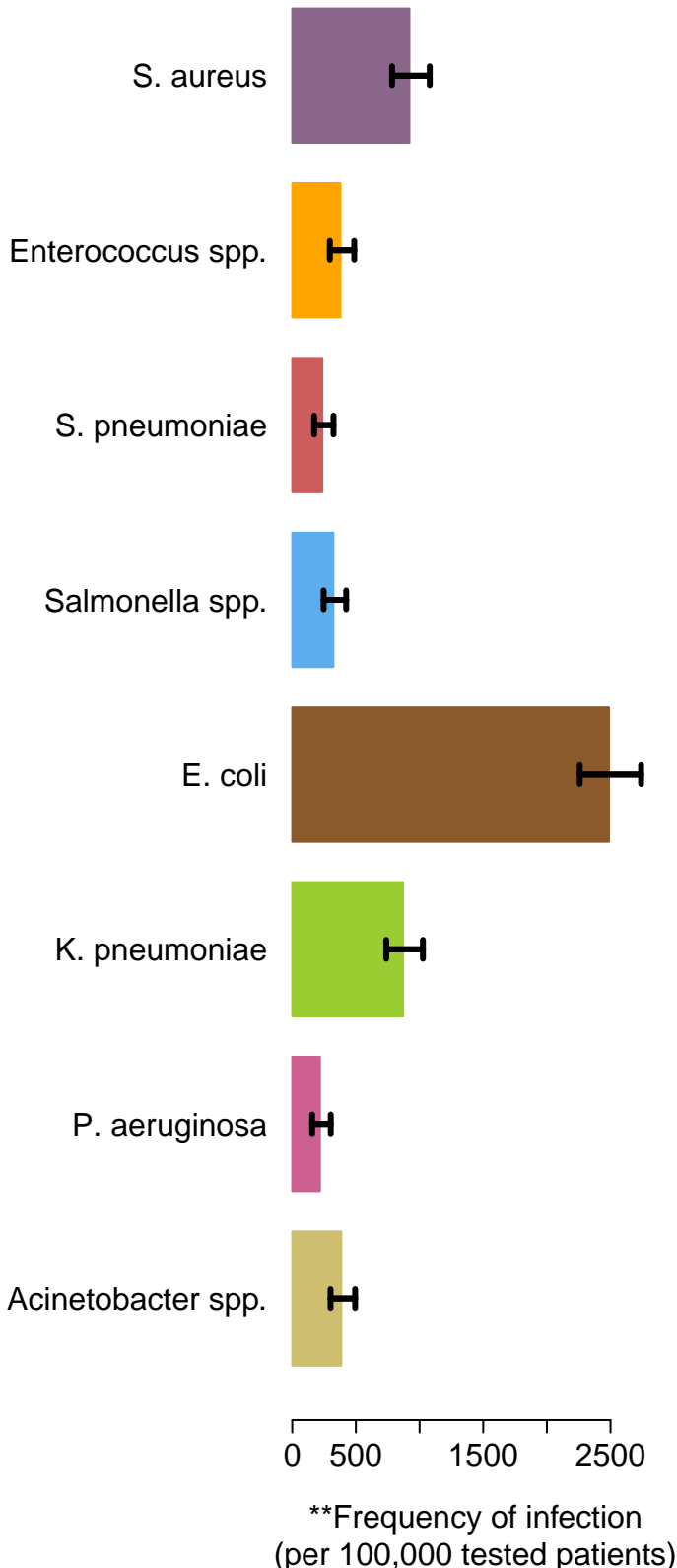
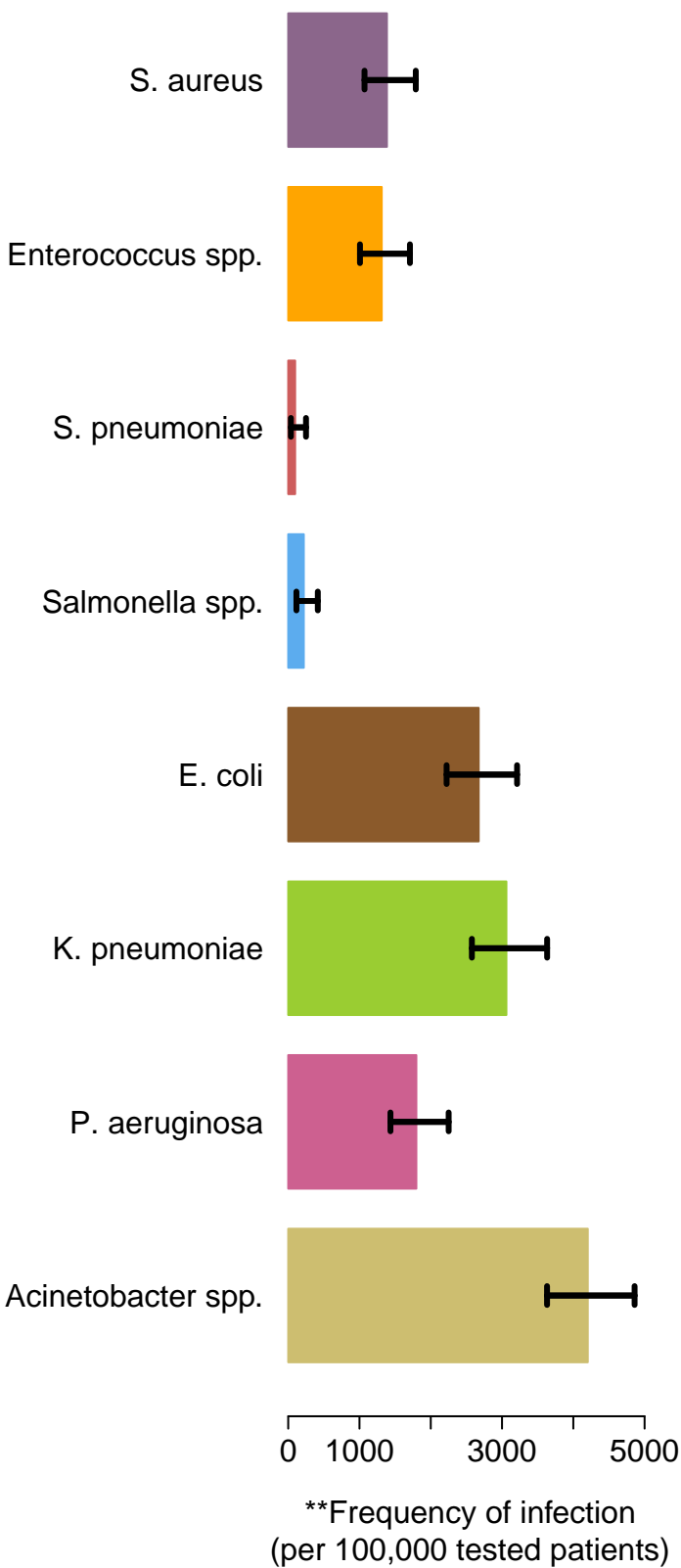| Organism	**Frequency (95% CI)
S. aureus	921 (785–1081)
Enterococcus spp.	380 (296–487)
S. pneumoniae	237 (173–325)
Salmonella spp.	324 (247–424)
E. coli	2488 (2259–2741)
K. pneumoniae	871 (739–1027)
P. aeruginosa	218 (157–303)
Acinetobacter spp.	386 (301–494)

**Frequency of infection
(per 100,000 tested patients)

*We apologise that the bacteria name in the table and in the figure are not written in italic. This is because of the R command we used. We will improve this in the next version.

**Frequency of infection per 100,000 tested patients on admission represents the number of patients with blood culture positive for a pathogen (numerator) over the total number of tested population on admission (denominator). The AMASS application de–duplicates the data by included only the first isolate of each patient per specimen type per reporting period.

CI = confidence interval; NS = non–susceptible; NA = Not available/reported/tested; 3GC = 3rd–generation cephalosporin

Blood: ***Pathogens**   **Hospital–origin**   *(No. of patients = 4116)*

Organism	**Frequency (95% CI)
S. aureus	1385 (1071–1790)
Enterococcus spp.	1312 (1007–1708)
S. pneumoniae	98 (38–250)
Salmonella spp.	219 (116–416)
E. coli	2673 (2223–3212)
K. pneumoniae	3062 (2578–3633)
P. aeruginosa	1798 (1435–2252)
Acinetobacter spp.	4204 (3632–4861)

**Frequency of infection
(per 100,000 tested patients)

*We apologise that the bacteria name in the table and in the figure are not written in italic. This is because of the R command we used. We will improve this in the next version.

**Frequency of infection per 100,000 tested population at risk of HAI represents the number of patients with blood culture positive for a pathogen (numerator) over the total number of tested population at risk of HAI (denominator). The AMASS application de–duplicates the data by included only the first isolate of each patient per specimen type per reporting period.

CI = confidence interval; NS = non–susceptible; NA = Not available/reported/tested; 3GC = 3rd–generation cephalosporin

Section [5]: Sample–based surveillance report with stratification by infection origin

Blood: ***AMR pathogens** **Community–origin** *(No. of patients = 16079)*
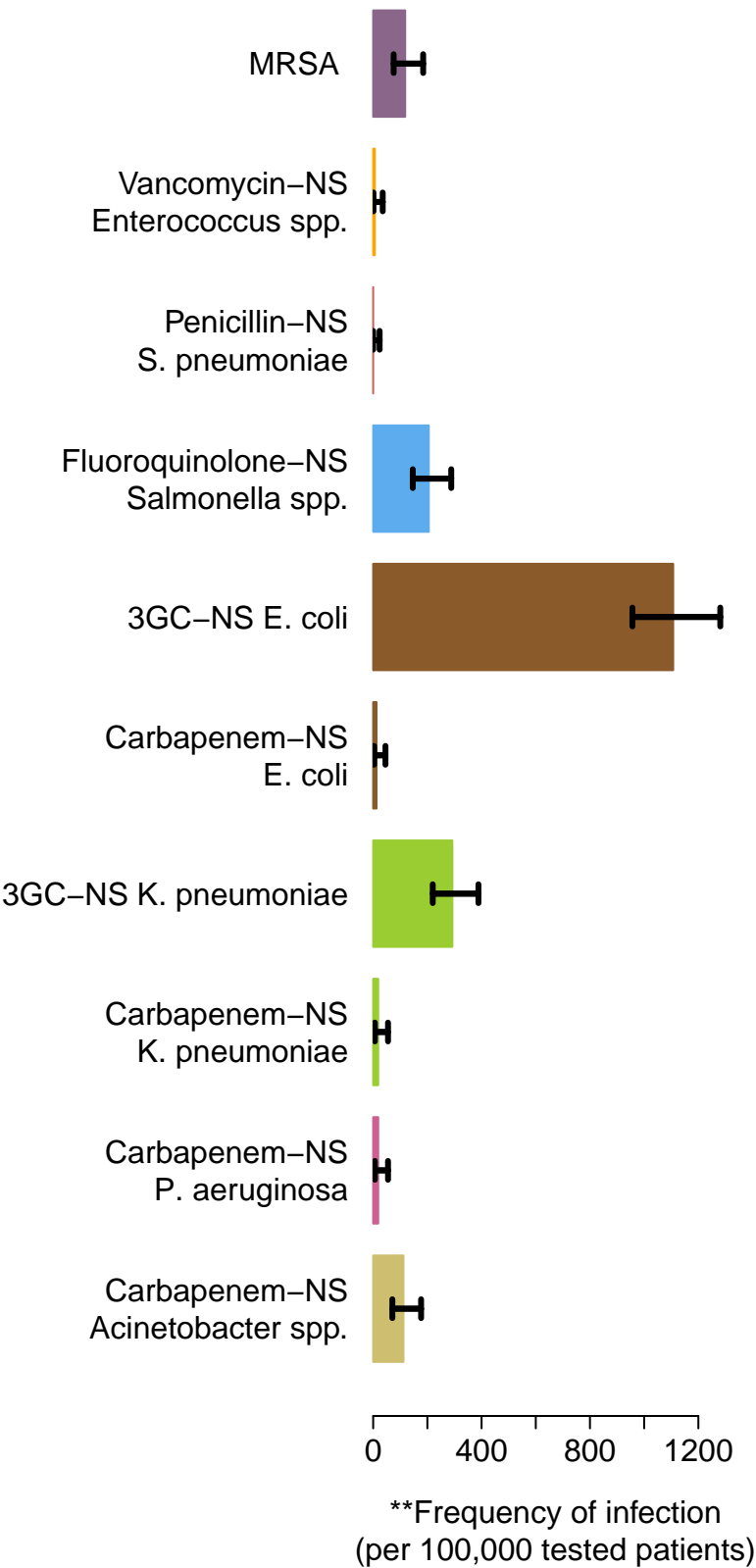
Organism	****Frequency (95% CI)**
MRSA	119 (76–185)
Vancomycin–NS Enterococcus spp.	7 (2–36)
Penicillin–NS S. pneumoniae	0 (0–24)
Fluoroquinolone–NS Salmonella spp.	206 (147–289)
3GC–NS E. coli	1108 (957–1281)
Carbapenem–NS E. coli	13 (4–46)
3GC–NS K. pneumoniae	293 (220–389)
Carbapenem–NS K. pneumoniae	19 (7–55)
Carbapenem–NS P. aeruginosa	19 (7–55)
Carbapenem–NS Acinetobacter spp.	112 (71–177)

****Frequency of infection
(per 100,000 tested patients)**

*We apologise that the bacteria name in the table and in the figure are not written in italic. This is because of the R command we used. We will improve this in the next version.

**Frequency of infection per 100,000 tested patients represents the number of patients with blood culture positive for a pathogen (numerator) over the total number of tested patients (denominator). The AMASS application de–duplicates the data by included only the first isolate of each patient per specimen type per reporting period.

CI = confidence interval; NS = non–susceptible; NA = Not available/reported/tested; 3GC = 3rd–generation cephalosporin

Section [5]: Sample–based surveillance report with stratification by infection origin

Blood: ***AMR pathogens** **Hospital–origin** *(No. of patients = 4116)*

**Frequency of infection (per 100,000 tested patients)
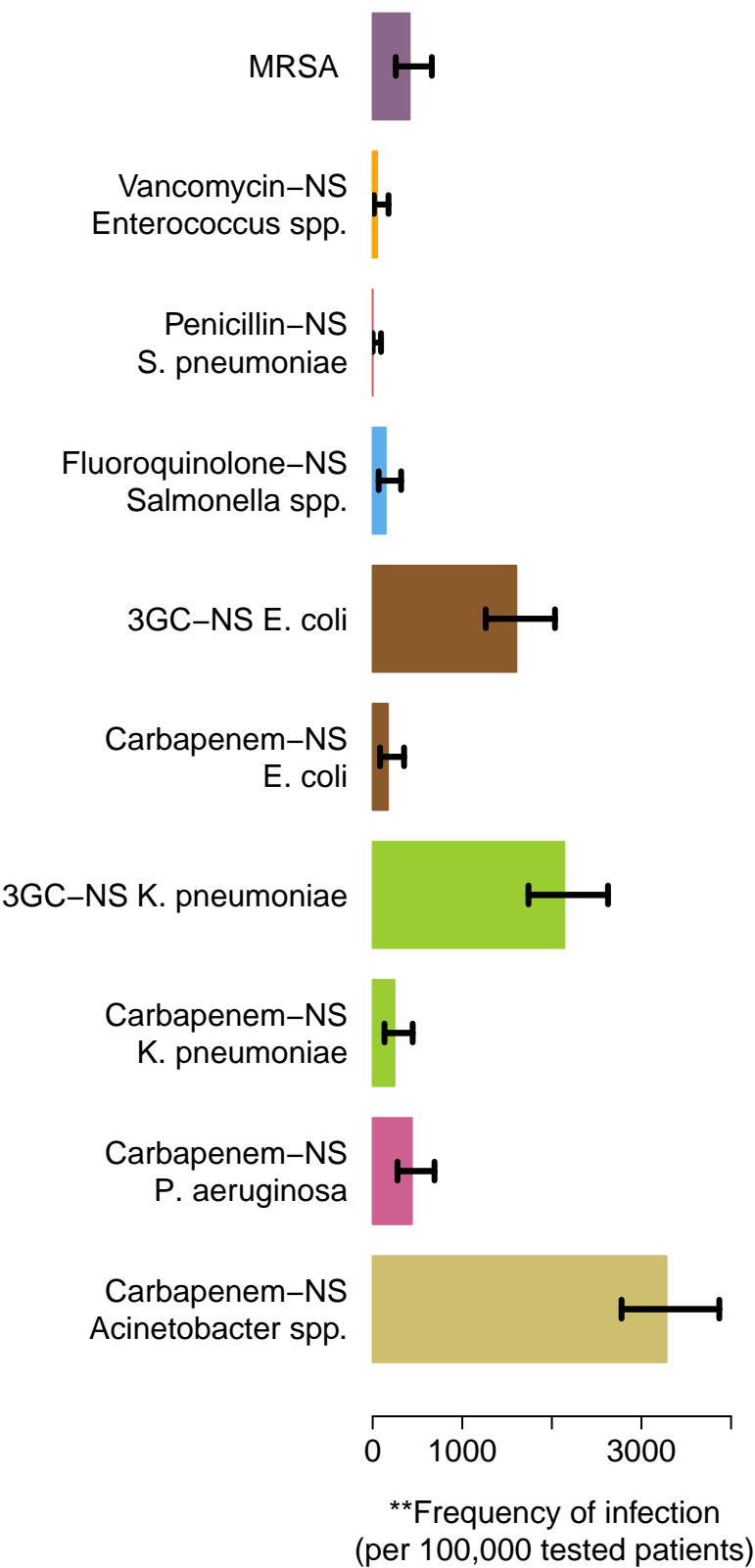
Organism	****Frequency (95% CI)**
MRSA	414 (259–661)
Vancomycin–NS Enterococcus spp.	49 (14–178)
Penicillin–NS S. pneumoniae	0 (0–94)
Fluoroquinolone–NS Salmonella spp.	146 (67–318)
3GC–NS E. coli	1604 (1263–2035)
Carbapenem–NS E. coli	171 (83–351)
3GC–NS K. pneumoniae	2138 (1739–2627)
Carbapenem–NS K. pneumoniae	243 (133–447)
Carbapenem–NS P. aeruginosa	438 (277–691)
Carbapenem–NS Acinetobacter spp.	3280 (2778–3870)

*We apologise that the bacteria name in the table and in the figure are not written in italic. This is because of the R command we used. We will improve this in the next version.

**Frequency of infection per 100,000 tested patients represents the number of patients with blood culture positive for a pathogen (numerator) over the total number of tested patients (denominator). The AMASS application de–duplicates the data by included only the first isolate of each patient per specimen type per reporting period.

CI = confidence interval; NS = non–susceptible; NA = Not available/reported/tested; 3GC = 3rd–generation cephalosporin

Section [6] Mortality involving AMR and antimicrobial–susceptible infections

Introduction

A surveillance report on mortality involving AMR infections and antimicrobial–susceptible infections with stratification by origin of infection is generated only if data on patient outcomes (i.e. discharge status) are available. Antimicrobial–resistant infection is a threat to modern health care, and the impact of the infection on patient outcomes is largely unknown. Performing analyses and generating reports on mortality often takes time and resources.

The term 'mortality involving AMR and antimicrobial–susceptible infections was used because the mortality reported was all–cause mortality. This measure of mortality included deaths caused by or related to other underlying and intermediate causes.

Here, AMASS summarized the overall mortality of patients with antimicrobial–resistant and antimicrobial–susceptible bacteria bloodstream infections (BSI).

Results:

The data included in the analysis had:

Sample collection dates ranged from   ***01 Jan 2015*** to ***31 Dec 2015***
Number of patients with blood culture positive for the origanism under the survey:

1608 patients
   Number of patients with community–origin BSI:

   936 patients
   Number of patients with hospital–origin BSI:

   607 patients

The hospital admission data file had:

Hospital admission dates ranging from   ***01 Jan 2015*** to ***31 Dec 2015***
Number of records in the raw hospital admission data:

101754 records
Number of patients included in the analysis (de–duplicated):

75923 patients
   Number of patients had death as outcome in any admission data records:

   3655 patients
   Overall mortality:

   5% (3655/75923)

The AMASS application merged the microbiology data file and hospital admission data file. The merged dataset was then de–duplicated so that only the first isolate per patient per specimen per reporting period was included in the analysis. The de–duplicated data was stratified by infection origin (community–origin infection or hospital–origin infection).

Organism	Mortality in patients with Community–origin BSI	Mortality in patients with Hospital–origin BSI
Staphylococcus aureus	*14% (21/148)*	*23% (13/57)*
Enterococcus spp.	*11% (7/61)*	*24% (13/54)*
Streptococcus pneumoniae	*13% (5/38)*	*0% (0/4)*
Salmonella spp.	*15% (8/52)*	*22% (2/9)*
Escherichia coli	*13% (51/400)*	*22% (24/110)*
Klebsiella pneumoniae	*21% (29/140)*	*30% (38/126)*
Pseudomonas aeruginosa	*17% (6/35)*	*32% (24/74)*
Acinetobacter spp.	*29% (18/62)*	*40% (70/173)*
Total:	*15% (145/936)*	*30% (184/607)*

The following figures and tables show the mortality of patients who were blood culture positive for antimicrobial non–susceptible and susceptible isolates.

Section [6] Mortality involving AMR and antimicrobial–susceptible infections

Staphylococcus aureus

Community–origin (*No. of patients = 148*)
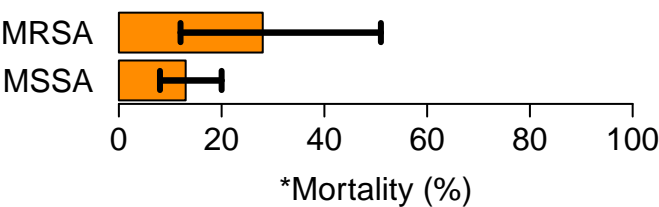
Type of pathogen	Mortality (n)	95% CI
MRSA	28% (5/18)	12%–51%
MSSA	13% (16/124)	8%–20%

Staphylococcus aureus

Hospital–origin (*No. of patients = 57*)
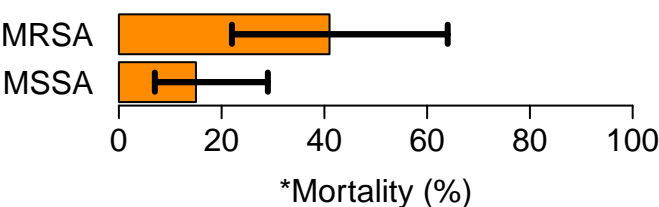
Type of pathogen	Mortality (n)	95% CI
MRSA	41% (7/17)	22%–64%
MSSA	15% (6/40)	7%–29%

Enterococcus spp.

Community–origin (*No. of patients = 61*)
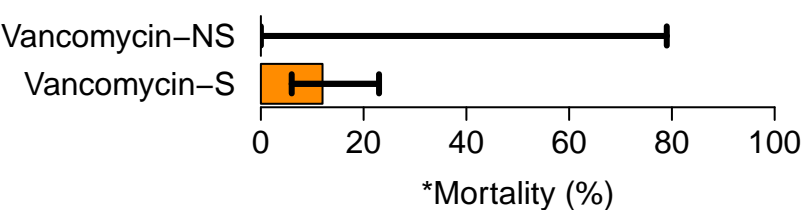
Type of pathogen	Mortality (n)	95% CI
Vancomycin–NS	0% (0/1)	0%–79%
Vancomycin–S	12% (7/59)	6%–23%

Enterococcus spp.

Hospital–origin (*No. of patients = 54*)
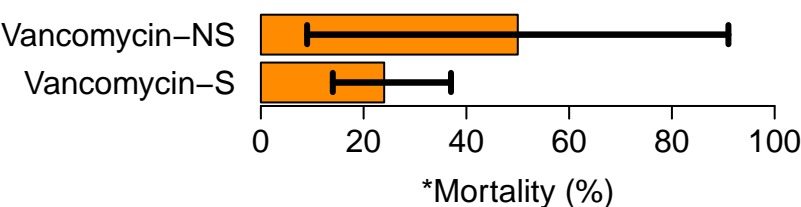
Type of pathogen	Mortality (n)	95% CI
Vancomycin–NS	50% (1/2)	9%–91%
Vancomycin–S	24% (12/50)	14%–37%

*Mortality is the proportion (%) of in–hospital deaths (all–cause deaths). This represents the number of in–hospital deaths (numerator) over the total number of patients with blood culture positive for the organism and the type of pathogen (denominator). The AMASS application de–duplicates the data by included only the first isolate per patient per specimen type per evaluation period. NS = non–susceptible; S = susceptible; CI = confidence interval; Fluoroquinolone–NS = NS to any fluoroquinolone tested; 3GC–NS = NS to any 3rd–generation cephalosporin and susceptible to carbapenem

Section [6] Mortality involving AMR and antimicrobial-susceptible infections
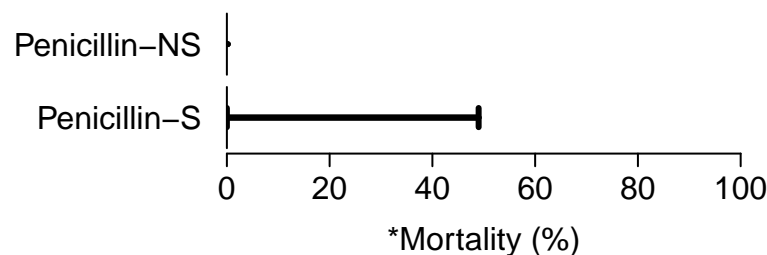
Streptococcus pneumoniae

Community-origin *(No. of patients = 38)*
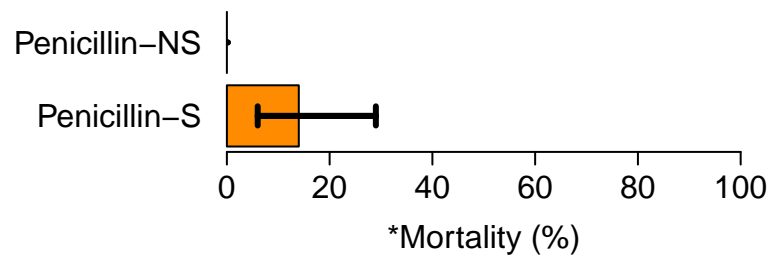
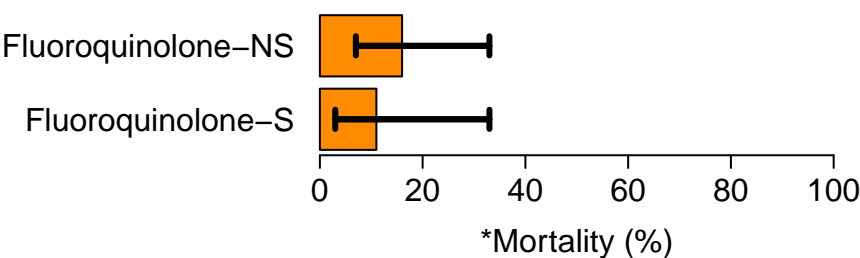| Mortality	Mortality (n)	95% CI
Penicillin-NS	NA	–
Penicillin-S	14% (5/36)	6%–29%

Streptococcus pneumoniae

Hospital-origin *(No. of patients = 4)*

Type of pathogen	Mortality (n)	95% CI
Penicillin-NS	NA	–
Penicillin-S	0% (0/4)	0%–49%

Salmonella spp.

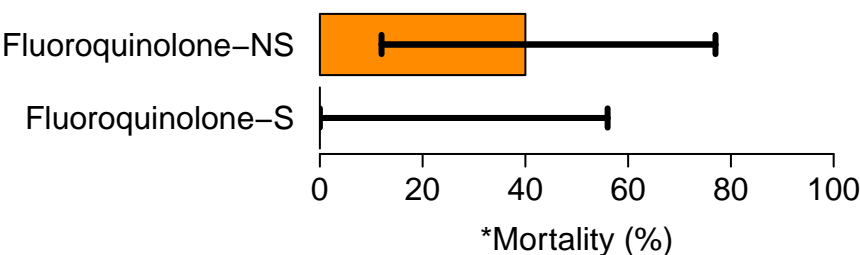### Community-origin *(No. of patients = 52)*

Type of pathogen	Mortality (n)	95% CI
Fluoroquinolone-NS	16% (5/31)	7%–33%
Fluoroquinolone-S	11% (2/18)	3%–33%

Salmonella spp.

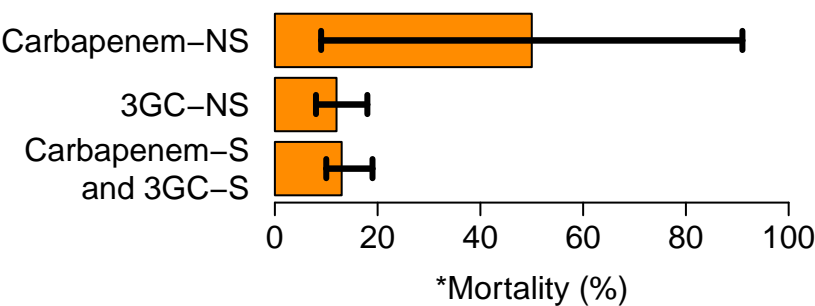### Hospital-origin *(No. of patients = 9)*

Type of pathogen	Mortality (n)	95% CI
Fluoroquinolone-NS	40% (2/5)	12%–77%
Fluoroquinolone-S	0% (0/3)	0%–56%

*Mortality is the proportion (%) of in-hospital deaths (all-cause deaths). This represents the number of in-hospital deaths (numerator) over the total number of patients with blood culture positive for the organism and the type of pathogen (denominator). The AMASS application de-duplicates the data by included only the first isolate per patient per specimen type per evaluation period. NS = non-susceptible; S = susceptible; CI = confidence interval; Fluoroquinolone-NS = NS to any fluoroquinolone tested; 3GC-NS = NS to any 3rd-generation cephalosporin and susceptible to carbapenem

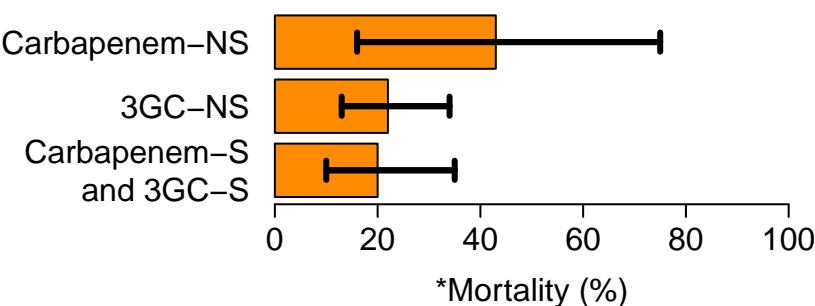## Section [6] Mortality involving AMR and antimicrobial–susceptible infections

Escherichia coli

*Mortality (%)

Community–origin (No. of patients = 400)

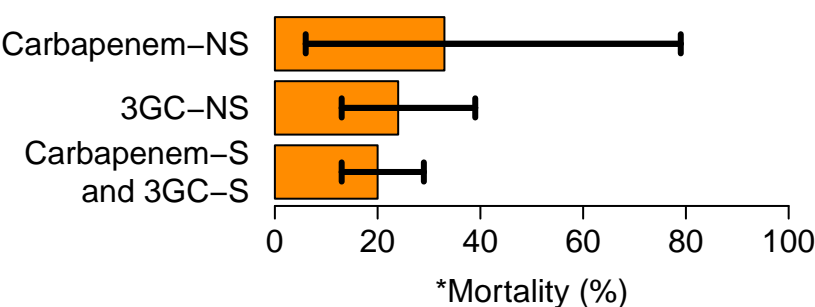| Type of pathogen	Mortality (n)	95% CI
Carbapenem–NS	50% (1/2)	9%–91%
3GC–NS	12% (21/171)	8%–18%
Carbapenem–S and 3GC–S	13% (29/216)	10%–19%

Escherichia coli

*Mortality (%)

Hospital–origin (No. of patients = 110)

Type of pathogen	Mortality (n)	95% CI
Carbapenem–NS	43% (3/7)	16%–75%
3GC–NS	22% (13/59)	13%–34%
Carbapenem–S and 3GC–S	20% (8/40)	10%–35%

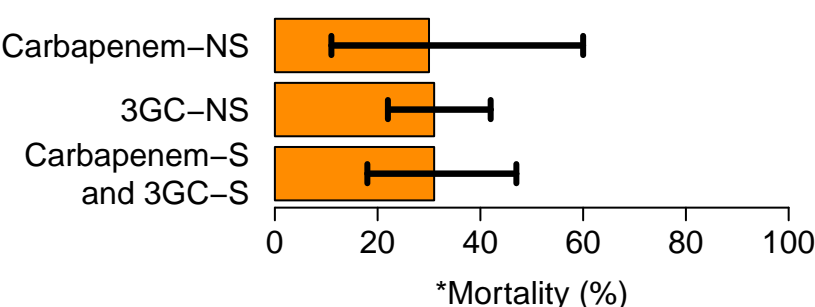### *Klebsiella pneumoniae*

*Mortality (%)

Community–origin (No. of patients = 140)

Type of pathogen	Mortality (n)	95% CI
Carbapenem–NS	33% (1/3)	6%–79%
3GC–NS	24% (10/42)	13%–39%
Carbapenem–S and 3GC–S	20% (18/92)	13%–29%

Klebsiella pneumoniae

*Mortality (%)

Hospital–origin (No. of patients = 126)

Type of pathogen	Mortality (n)	95% CI
Carbapenem–NS	30% (3/10)	11%–60%
3GC–NS	31% (24/77)	22%–42%
Carbapenem–S and 3GC–S	31% (11/36)	18%–47%

*Mortality is the proportion (%) of in–hospital deaths (all–cause deaths). This represents the number of in–hospital deaths (numerator) over the total number of patients with blood culture positive for the organism and the type of pathogen (denominator). The AMASS application de–duplicates the data by including only the first isolate per patient per specimen type per evaluation period.
NS = non–susceptible; S = susceptible; CI = confidence interval; Carbapenem–NS = NS to any carbapenems tested;
3GC–NS = NS to any 3rd–generation cephalosporin and susceptible to carbapenem

Section [6] Mortality involving AMR and antimicrobial–susceptible infections
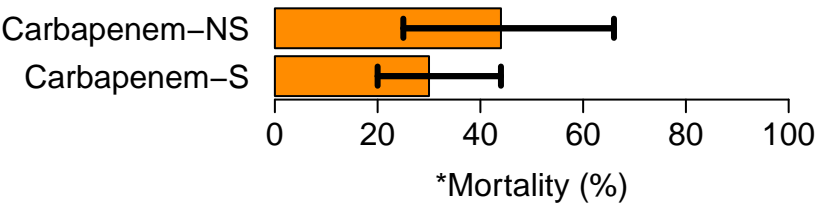
Pseudomonas aeruginosa

Community–origin (No. of patients = 35)
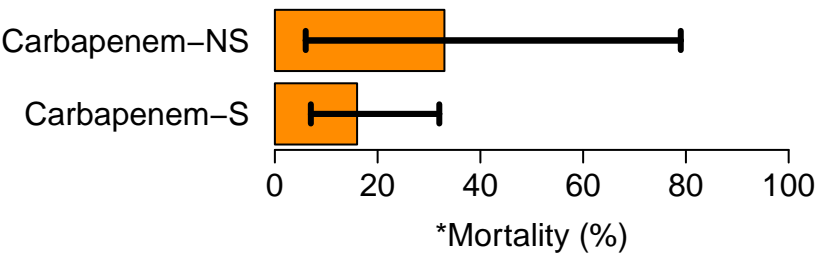
Type of pathogen	Mortality (n)	95% CI
Carbapenem–NS	33% (1/3)	6%–79%
Carbapenem–S	16% (5/32)	7%–32%

Pseudomonas aeruginosa

Hospital–origin   (No. of patients = 74)

Type of pathogen	Mortality (n)	95% CI
Carbapenem–NS	44% (8/18)	25%–66%
Carbapenem–S	30% (16/53)	20%–44%

Acinetobacter spp.

Community–origin (No. of patients = 62)
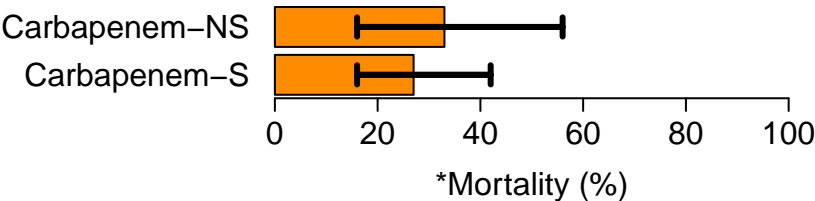
Type of pathogen	Mortality (n)	95% CI
Carbapenem–NS	33% (6/18)	16%–56%
Carbapenem–S	27% (12/44)	16%–42%

Acinetobacter spp.

Hospital–origin   (No. of patients = 173)
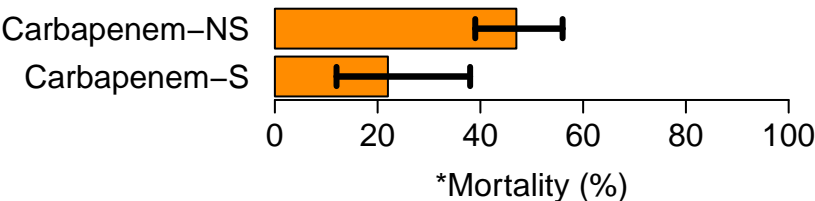
Type of pathogen	Mortality (n)	95% CI
Carbapenem–NS	47% (62/131)	39%–56%
Carbapenem–S	22% (8/36)	12%–38%

*Mortality is the proportion (%) of in–hospital deaths (all–cause deaths). This represents the number of in–hospital deaths (numerator) over the total number of patients with blood culture positive for the organism and the type of pathogen (denominator). The AMASS application de–duplicates the data by including only the first isolate per patient per specimen type per evaluation period. NS = non–susceptible; S = susceptible; CI = confidence interval; Carbapenem–NS = NS to any carbapenems tested; 3GC–NS = NS to any 3rd–generation cephalosporin and susceptible to carbapenem

Methods used by the AMASS application

Data source:

For each run (double–click on AMASS.bat file), the AMASS application used the microbiology data file (microbiology_data) and the hospital admission data file (hospital_ admission_data) that were stored in the same folder as the application file. Hence, if the user would like to update, correct, revise or change the data, the data files in the folder should be updated before the AMASS.bat file is double–clicked again. A new report based on the updated data would then be generated.

Requirements:

– Computer with Microsoft Windows 7 or 10

AMASS may work in other versions of Microsoft Windows and other operating systems. However, thorough testing and adjustment have not been performed.

– AMASS.zip package file

The AMASS application is to be downloaded from http://www.amass.website, and unzipped to generate an AMASS folder that could be stored under any folder in the computer. The AMASS folder contains 4 files (AMASS.bat, z_Rcode.R, dictionary_for_microbiology_ data.xlsx, and dictionary_for_hospital_admission_data.xlsx), and 5 folders (Variables, Rprogram, Example_Dataset_1_WHONET, Example_Dataset_2, and ResultData).

– Microbiology data file (microbiology_data in .csv or .xlsx file format)

The user needs to obtain microbiology data, and then copy & paste this data file into the same folder as the AMASS.bat file.

– [Optional] Hospital admission data file (hospital_admission_data)

If available, the user could obtain hospital admission data, and then copy & paste this data file into the same folder as the AMASS.bat file.

Not required:

– Internet to run AMASS application

The AMASS application will run offline. No data are transferred while the application is running and reports are being generated; the reports are in PDF format (do not contain any patient identifier) and can be shared under the user's jurisdiction.

– R

The download package (AMASS.zip) included R portable and R libraries that the AMASS application requires. The user does not need to install any programme before using the AMASS. The user also does not have to uninstall R prgramme if the computer already has the R prgramme installed. The user does not need to know how to use R prgramme.

Note:
[1] Please ensure that the file names of microbiology data file (microbiology_data) and the hospital admission data file (hospital_admission_data) are identical to what is written here. Please make sure that all are lower−cases with an underscore '_' at each space.
[2] Please ensure that both microbiology and hospital admission data files have no empty rows before the row of the variable names (i.e. the variable names are the first row in both files).
[3] For the first run, an user may need to fill the data dictionary files to make sure that the AMASS application understands your variable names and values.

AMASS uses a tier−based approach. In cases when only the microbiology data file with the results of culture positive samples is available, only section one and two would be generated for users. Section three would be generated only when data on admission date are available. This is because these data are required for the stratification by origin of infection. Section four would be generated only when data of specimens with culture negative (no microbial growth) are available in the microbiology data. This is because these are required for the sample−based approach. Section five would be generated only when both data of specimens with culture negative and admission date are available. Section six would be generated only when mortality data are available.

Mortality was calculated from the number of in−hospital deaths (numerator) over the total number of patients with blood culture positive for the organism (denominator). Please note that this is the all−cause mortality calculated using the outcome data in the data file, and may not necessarily represent the mortality directly due to the infections.

How to use data dictionary files
In cases when variable names in the microbiology and hospital admission data files were not the same as the one that AMASS used, the data dictionary files could be edited. The raw microbiology and hospital admission data files were to be left unchanged. The data dictionary files provided could be edited and re−used automatically when the microbiology and hospital admission data files were updated and the AMASS.bat were to be double−clicked again (i.e. the data dictionary files would allow the user to re−analyze data files without the need to adjust variable names and data value again every time).

For example:

If variable name for 'hospital number' is written as 'hn' in the raw data file, the user would need to add 'hn' in the cell next to 'hospital_number'. If data value for blood specimens is defined by 'Blood–Hemoculture' in the raw data file, then the user would need to add 'Blood–Hemoculture' in the cell next to 'blood_specimen'.

Dictionary file (dictionary_for_microbiology_data.xlsx) may show up as in the table below:

Variable names used in AMASS	Variable names used in your microbiology data file	Requirements
Don't change values in this column, but you can add rows with similar values if you need	Change values in this column to represent how variable names are written in your raw microbiology data file	
hospital_number		Required
Values described in AMASS	**Values used in your microbiology data file**	**Requirements**
blood_specimen		Required

Please fill in your variable names as follows:

Variable names used in AMASS	Variable names used in your microbiology data file	Requirements
Don't change values in this column, but you can add rows with similar values if you need	Change values in this column to represent how variable names are written in your raw microbiology data file	
hospital_number	hn	Required
Values described in AMASS	**Values used in your microbiology data file**	**Requirements**
blood_specimen	Blood–Hemoculture	Required

Then, save the file. For every time the user double–clicked AMASS.bat, the application would know that the variable named 'hn' is similar to 'hospital_number' and represents the patient identifier in the analysis.

Organisms included in this report:
- *Staphylococcus aureus*
- *Enterococcus* spp.
- *Streptococcus pneumoniae*
- *Salmonella* spp.
- *Escherichia coli*
- *Klebsiella pneumoniae*
- *Pseudomonas aeruginosa*
- *Acinetobacter* spp.

The eight organisms and antibiotics included in the report were selected based on the global priority list of antibiotic resistant bacteria and Global Antimicrobial Resistance Surveillance System (GLASS) of WHO [1,2].

Definitions:

The definitions of infection origin proposed by the WHO GLASS was used [1]. In brief, community–origin bloodstream infection (BSI) was defined for patients in the hospital within the first two calendar days of admission when the first blood culture positive specimens were taken. Hospital–origin BSI was defined for patients in the hospital longer than the first calendar days of admission when the first blood culture positive specimens were taken. In cases when the user had additional data on infection origin defined by infection control team or based on referral data, the user could edit the data dictionary file (variable name 'infection_origin') and the AMASS application would use the data of that variable to stratify the data by origin of infection instead of the above definition. However, in cases when data on infection origin were not available (as in many hospitals in LMICs), the above definition would be calculated based on admission date and specimen collection date (with cutoff of 2 calendar days) and used to classify infections as community–origin or hospital–origin.

De–duplication:

When more than one blood culture was collected during patient management, duplicated findings of the same patient were excluded (de–duplicated). Only one result was reported for each patient per sample type (blood) and surveyed organisms (listed above). For example, if two blood cultures from the same patient had *E. coli*, only the first would be included in the report. If there was growth of *E. coli* in one blood culture and of *K. pneumoniae* in the other blood culture, then both results would be reported. One would be for the report on *E. coli* and the other one would be for the report on *K. pneumoniae.*

References:

[1] World Health Organization (2018) Global Antimicrobial Resistance Surveillance System (GLASS) Report. Early implantation 2016–2017. http://apps.who.int/iris/bitstream/handle/10665/259744/ 9789241513449–eng.pdf. (accessed on 3 Dec 2018)

[2] World Health Organization (2017) Global priority list of antibiotic–resistant bacteria to guide research, discovery, and development of new antibiotics. https://www.who.int/medicines/publications/WHO–PPL– Short_Summary_25Feb–ET_NM_WHO.pdf. (accessed on 3 Dec 2018)

Investigator team

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