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Antimicrobial Resistance (AMR) Surveillance on Blood Culture Specimen in Public Hospitals and Clinics - Hospital Authority AMR Data (2019)

May 2021

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Contents Outline

- Background
- Methodology
- Results
    1. Overview on patients with blood culture
    2. Overview on WHO priority organisms isolates from blood
    3. Antimicrobial susceptibility test result
- Remarks on interpretation of results
- Summary
- Recommendations

Background

Background

- The Hong Kong Strategy and Action Plan 2017-2022 was issued in July 2017
- Activity 1.2.1 suggests harmonising AMR surveillance reporting criteria with reference to the Global Antimicrobial Resistance Surveillance System (GLASS), developed by the World Health Organization (WHO)
- This presentation briefly accounts the surveillance findings for year 2019

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Methodology

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WHO GLASS Recommendations (1)

- Based on *WHO GLASS Manual for Early Implementation (2015):*
  - WHO Priority Organisms captured:
    - *Escherichia coli*
    - *Klebsiella pneumoniae*
    - *Staphylococcus aureus*
    - *Salmonella* spp.
    - *Acinetobacter* spp.
    - *Streptococcus pneumoniae*
  - Organisms other than the above were grouped as “Other spp.”
  - Location of onset
    - Community-onset - organisms isolated from blood specimen collected in non-inpatient settings or within 48 hours after hospital admission
    - Hospital-onset - organisms isolated from blood specimen collected more than 48 hours after hospital admission
    - Using 48 hours instead of 2 calendar days of WHO as agreed by HA

WHO GLASS Recommendations (2)

- Based on *WHO GLASS Manual for Early Implementation (2015):*
  - Removal of duplicate results (deduplication)
    - For each surveillance period (one calendar year), only the first result would be reported for each patient per specimen type per organism for the same location of onset
  - Antimicrobial susceptibility test (AST) result being “Intermediate” or “Resistant” was considered as “non-susceptible”
  - AST results derived from < 10 isolates per calendar year were excluded from analysis

Local Adaptation

- Taking local context into account, the following modifications were also agreed in consultation with HA experts in the Working Group:
  - To avoid misleading or interference by selection bias, percentages of non-susceptibility derived from less than 70% of total isolates were not reported, or remarked to remind readers to interpret with caution
  - Location of onset for *Salmonella* spp. and *Streptococcus pneumoniae*
    - Information on location of onset was not considered when analysing AST results, as they rarely cause hospital-associated infections
    - AST results were interpreted as "community (undifferentiated) onset" as a whole
    - WHO's definition of community- / hospital-onset still applies when presenting the organisms distribution by location of onset
  - "Day-14" rule
    - Positive cultures for the same organism within a 14-day period from the same patient would be regarded as a single episode

Graphical Illustration of "Day-14" rule

Scope of Data

- The following information were collected from patients who had blood culture:
  - Demographic data
  - Microbiology data
    - Organisms cultured
    - AST results
      - Susceptible (sensitive)
      - Non-susceptible (intermediate or resistant)

Broad-spectrum Antimicrobials (Big Guns)

- Where appropriate, AST results of the following broad-spectrum antimicrobials identified by experts in HA were examined because of their importance on treating resistant infections
  - Piperacillin/tazobactam
  - Ceftazidime
  - Cefoperazone/sulbactam
  - Cefepime
  - Ceftaroline fosamil
  - Ceftolozane/tazobactam
  - Ceftazidime/avibactam
  - Meropenem
  - Ertapenem
  - Imipenem/cilastatin
  - Vancomycin
  - Linezolid
  - Daptomycin
  - Colistin
  - Teicoplanin

Scope of Reporting

- Overview on patients with blood culture
  - Number of patients from whom a blood culture was taken
- Overview on WHO priority organisms isolated from blood
  - Number of patients with positive and negative culture results
  - Distribution of organisms by location of onset
- AST results on WHO priority organisms
  - Number and % of patients with non-susceptibility results
  - Trend of antimicrobial non-susceptibility
    - 2018 vs 2019
    - 2016 - 2019 trend

Statistical Analysis on AST Results

- % non-susceptibility (% NS) in 2018 vs 2019
  - Fisher's exact test or chi-square test for comparison
  - P <0.05 was considered statistically significant
- 2016 – 2019 trend analysis
  - Year 2016 was chosen as the baseline for comparison as the Hong Kong Strategy and Action Plan on AMR was issued in 2017 and such decision was endorsed by the High Level Steering Committee
  - One-way Cochran-Armitage test was used to look for trend
  - P <0.05 was considered statistically significant
  - P <0.01 was considered statistically highly significant
  - For ease of presentation of trends with $p < 0.05$
    - Increasing trend of % NS – Red in colour
    - Decreasing trend of % NS – Green in colour

Results

1. Overview on patients with blood culture

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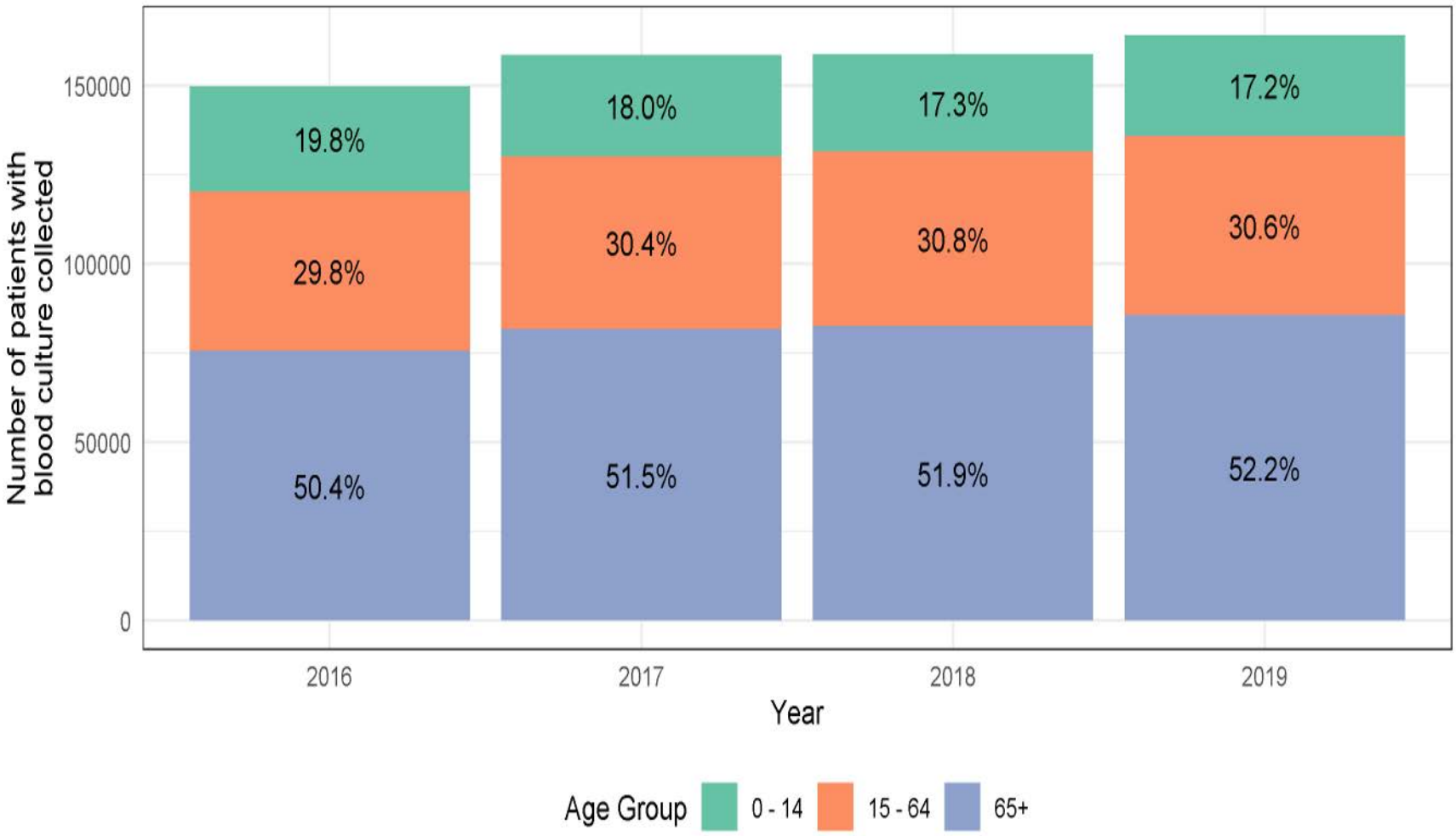
Age distribution of patients with blood culture



- ⇧ No. of patients with blood culture (~150,000 in 2016 to ~164,000 in 2019)
- > 50% patients aged 65 years or above each year

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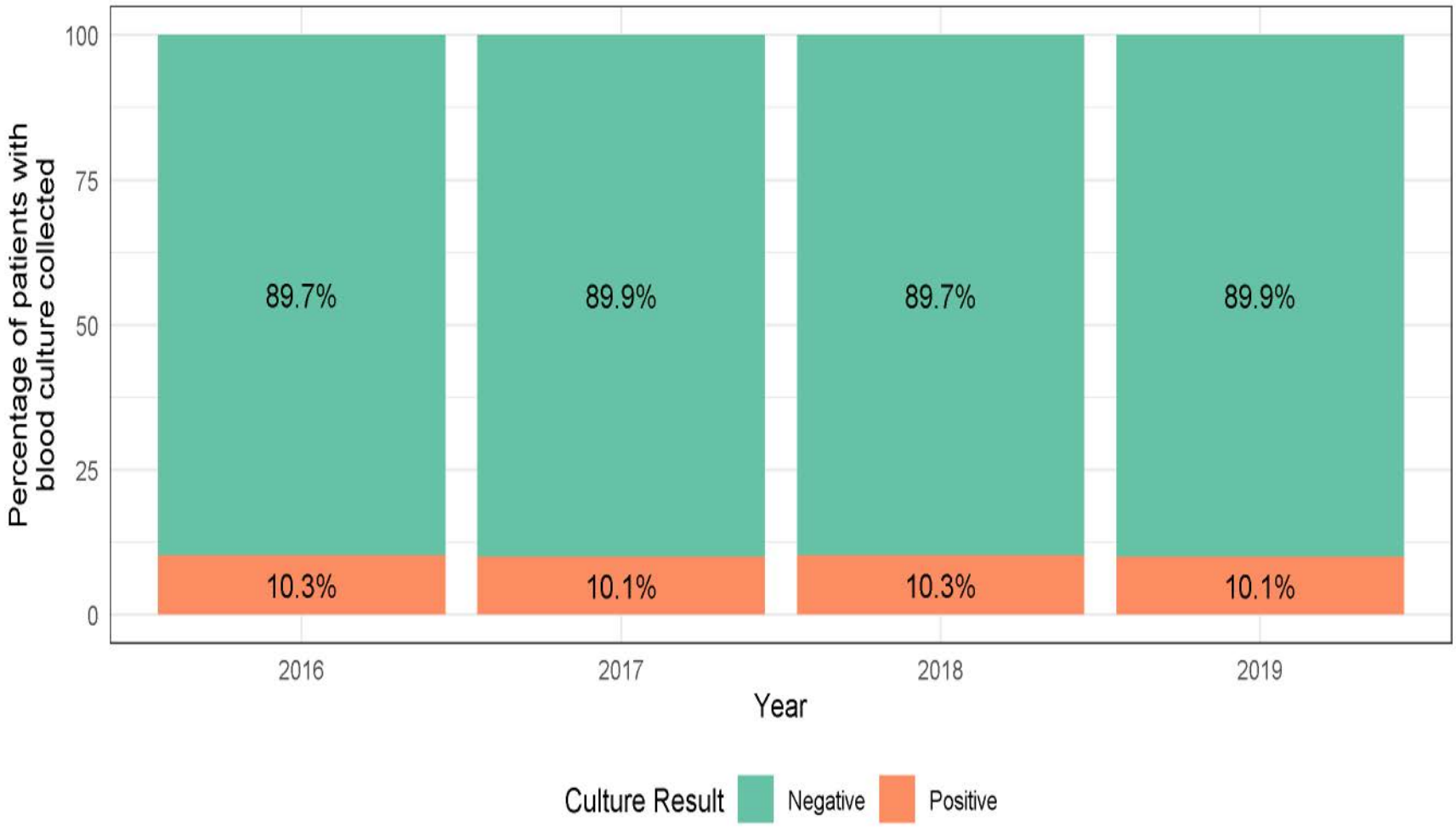
Percentage of Patients with Blood Culture



- % patients with +ve blood culture remained stable over the past years

Results

2. Overview on WHO priority organisms isolated from blood

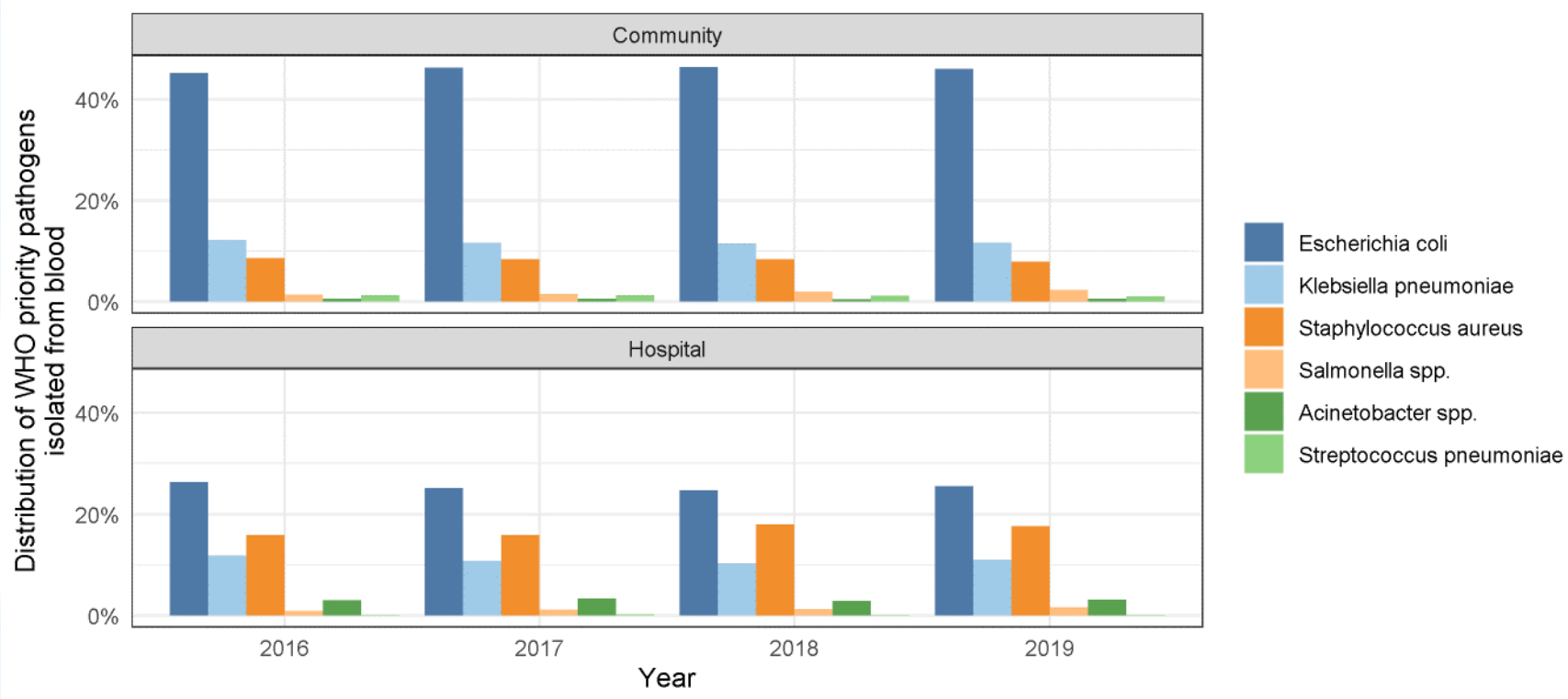
Distribution of Organisms by Year

Organism	No. (%) of patients with +ve blood culture by organism and year			
	2016	2017	2018	2019
Escherichia coli	6,300 (40.9%)	6,600 (41.2%)	6,800 (41.2%)	6,800 (41.2%)
Klebsiella pneumoniae	1,900 (12.3%)	1,900 (11.7%)	1,900 (11.4%)	1,900 (11.7%)
Staphylococcus aureus	1,700 (10.7%)	1,700 (10.6%)	1,800 (11.2%)	1,800 (10.8%)
Salmonella spp.	200 (1.3%)	200 (1.5%)	300 (1.8%)	400 (2.2%)
Acinetobacter spp.	200 (1.3%)	200 (1.4%)	200 (1.2%)	200 (1.3%)
Streptococcus pneumoniae	200 (1.0%)	200 (1.0%)	100 (0.9%)	100 (0.8%)
Other spp.	7,000 (45.0%)	7,200 (45.0%)	7,300 (44.5%)	7,400 (44.9%)
Total no. of patients	15,500	16,000	16,400	16,600

Note:

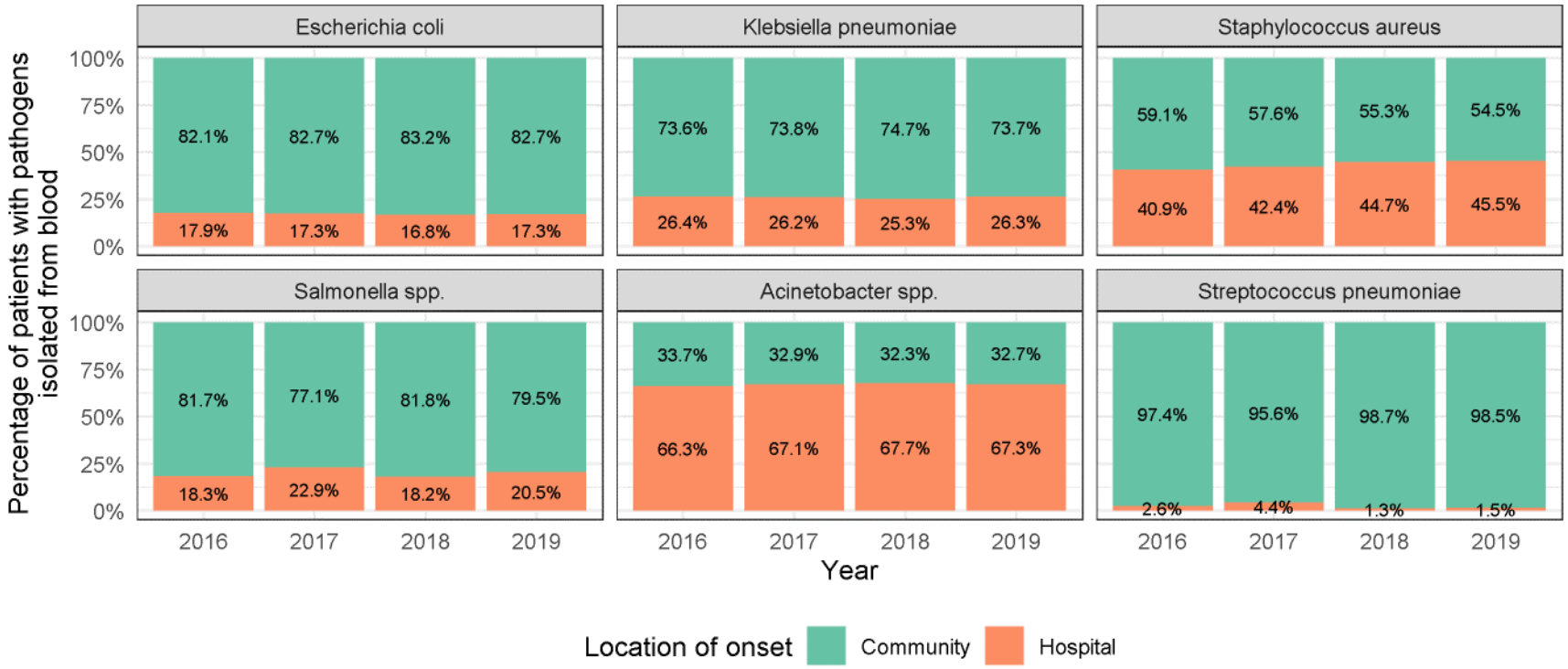
- Headcounts rounded to nearest hundred, percentages rounded to one decimal place
- A patient might have blood culture(s) with growth of multiple organisms

Distribution of Organisms by Location of Onset (1)



- By location of onset (following WHO's definition):
  - Distributions of the 6 priority organisms of hospital- and community-onset were similar over the years
  - For community-onset specimens in 2019, 46.0% of patients with +ve blood culture had *Escherichia coli* isolated, followed by *Klebsiella pneumoniae* (11.6%) and *Staphylococcus aureus* (7.9%)
  - For hospital-onset specimens in 2019, 25.5% of patients with +ve blood culture had *Escherichia coli* isolated, followed by *Staphylococcus aureus* (17.6%) and *Klebsiella pneumoniae* (11.0%)

Distribution of Organisms by Location of Onset (2)



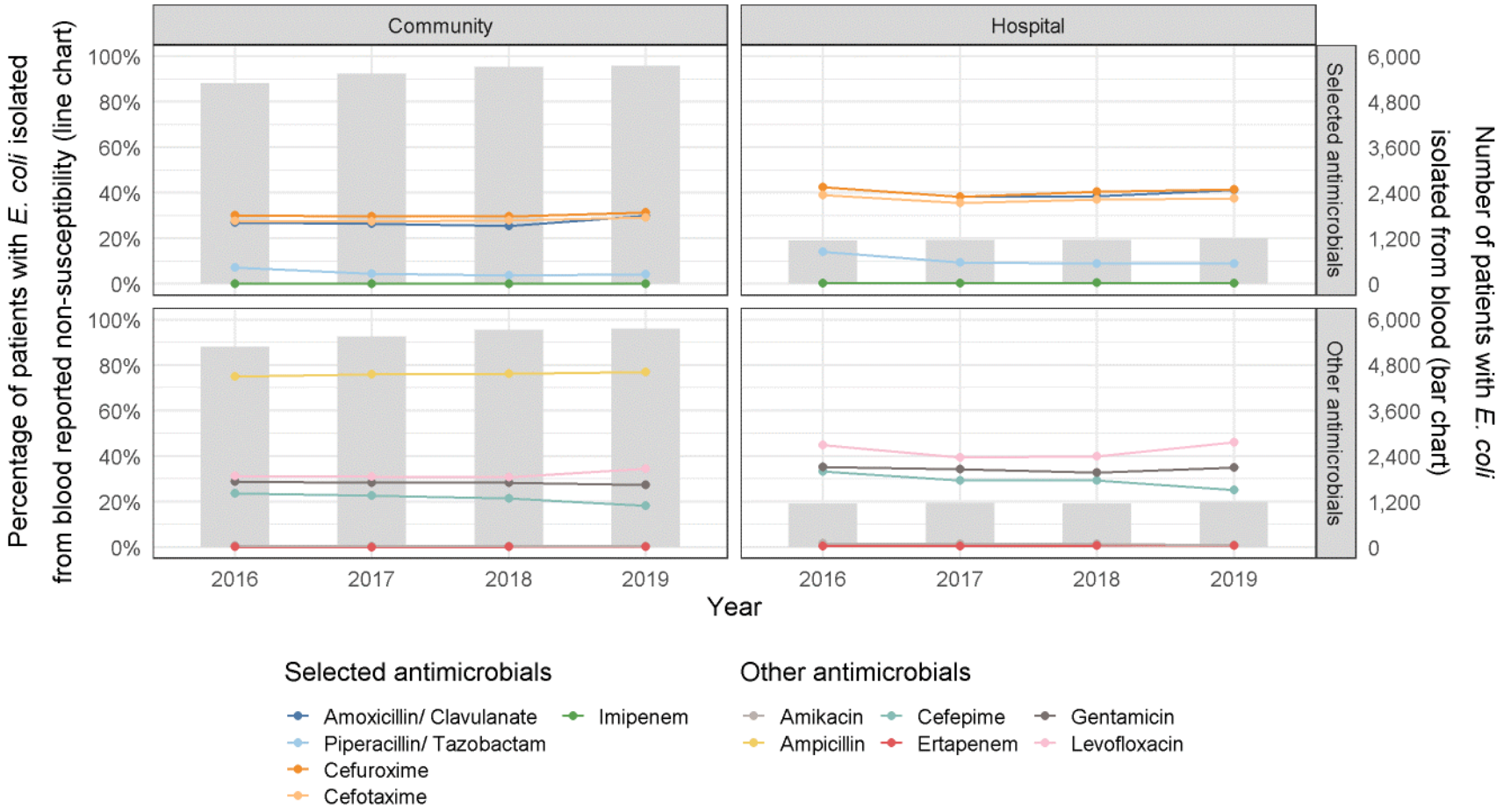
In Year 2019:

- *Escherichia coli* (82.7%), *Klebsiella pneumoniae* (73.7%), *Salmonella* spp. (79.5%) and *Streptococcus pneumoniae* (98.5%) were predominantly community-onset
- *Acinetobacter* spp. (67.3%) was predominantly hospital-onset

Results

3.1 AST results for *Escherichia coli*

AST results for *E. coli* - Overview



- % NS to selected antimicrobials (i.e. more commonly used antimicrobials) were lower among *E. coli* isolates of community- than those of hospital-onset

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AST results for *E. coli* - 2018 vs 2019

Antimicrobial group	Antimicrobial (Big guns in yellow)	Community Onset			Hospital Onset		
		% NS		p-value†	% NS		p-value†
		2018	2019	18 vs 19	2018	2019	18 vs 19
Penicillins with extended spectrum	Ampicillin	76.1%	76.9%	-	-	-	-
Combinations of penicillins, incl. beta-lactamase inhibitors	Amoxicillin/ Clavulanate	25.4%	29.8%	<0.05	38.6%	41.2%	-
	Piperacillin/ Tazobactam	3.7%	4.4%	-	9.0%	9.0%	-
Second-generation cephalosporins	Cefuroxime	29.6%	31.3%	-	40.6%	41.5%	-
Third-generation cephalosporins	Cefotaxime	28.0%	29.2%	-	37.2%	37.7%	-
	Ceftazidime	13.3%	14.7%	-	18.3%*	21.1%	-
Fourth-generation cephalosporins	Cefepime	21.5%	18.2%	<0.05	29.4%	25.2%	<0.05
Carbapenems	Ertapenem	0.1%	0.06%	-	0.6%	0.6%	-
	Imipenem	0.05%	0.02%	-	0.5%	0.3%	-
Other aminoglycosides	Gentamicin	28.2%	27.2%	-	32.7%	35.0%	-
	Amikacin	0.4%	0.4%	-	1.4%	0.8%	-
Fluoroquinolones	Levofloxacin‡	30.8%	34.6%	<0.05	40.0%	46.1%	<0.05

* Non-susceptibility percentage should be interpreted with caution as the figure is derived from less than 70% of total isolates for surveillance. The figure may be affected by selection bias.

†P-value was calculated using chi-squared test or Fisher's exact test, whether appropriate

‡Revised levofloxacin interpretive criteria for Enterobacteriaceae (except *Salmonella* spp.) was released by CLSI in 2019. The increase in 2019 may be contributed by a change in CLSI criteria.

- Statistically significant results related to broad-spectrum antimicrobials
  - Both community- and hospital-onset isolates showed ⇩ % NS towards cefepime

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AST results for *E. coli*
Trend 2016-2019 (Community Onset)

Antimicrobial group	Antimicrobial (Big guns in yellow)	Community Onset				
		% NS				p-value†
		2016	2017	2018	2019	2016 - 2019
Penicillins with extended spectrum	Ampicillin	74.9%	75.9%	76.1%	76.9%	↗ p <0.05
Combinations of penicillins, incl. beta-lactamase inhibitors	Amoxicillin/ Clavulanate	27.1%	26.4%	25.4%	29.8%	↗ p <0.01
	Piperacillin/ Tazobactam	7.2%	4.5%	3.7%	4.4%	↘ p <0.01
Second-generation cephalosporins	Cefuroxime	30.1%	29.7%	29.6%	31.3%	-
Third-generation cephalosporins	Cefotaxime	27.8%	27.4%	28.0%	29.2%	↗ p <0.05
	Ceftazidime	15.0%	13.9%*	13.3%	14.7%	-
Fourth-generation cephalosporins	Cefepime	23.6%	22.6%	21.5%	18.2%	↘ p <0.01
Carbapenems	Ertapenem	0.1%	0.04%	0.1%	0.06%	-
	Imipenem	0.04%	0%	0.05%	0.02%	-
Other aminoglycosides	Gentamicin	28.9%	28.3%	28.2%	27.2%	↘ p <0.05
	Amikacin	0.7%	0.4%	0.4%	0.4%	↘ p <0.05
Fluoroquinolones	Levofloxacin‡	31.2%	31.0%	30.8%	34.6%	↗ p <0.01

Legend: ↗ Increasing trend; ↘ Decreasing trend

* Non-susceptibility percentage should be interpreted with caution as the figure is derived from less than 70% of total isolates for surveillance. The figure may be affected by selection bias.

†P-value was calculated using Cochran-Armitage test, only trends with statistical significance ($p<0.05$) and high statistical significance ($p<0.01$) were reported

‡Revised levofloxacin interpretive criteria for Enterobacteriaceae (except *Salmonella* spp.) was released by CLSI in 2019. The increase in 2019 may be contributed by a change in CLSI criteria.

- Statistically significant results related to broad-spectrum antimicrobials
  - ⇩ trends towards piperacillin/tazobactam and cefepime

AST results for *E. coli*
Trend 2016-2019 (Hospital Onset)

Antimicrobial group	Antimicrobial (Big guns in yellow)	Hospital Onset				
		% NS				p-value†
		2016	2017	2018	2019	2016 - 2019
Penicillins with extended spectrum	Ampicillin	85.3%	85.5%	85.8%*	84.9%*	-
Combinations of penicillins, incl. beta-lactamase inhibitors	Amoxicillin/ Clavulanate	42.6%	38.3%	38.6%	41.2%	-
	Piperacillin/ Tazobactam	14.1%	9.5%	9.0%	9.0%	↘ p <0.01
Second-generation cephalosporins	Cefuroxime	42.5%	38.4%	40.6%	41.5%	-
Third-generation cephalosporins	Cefotaxime	39.1%	35.6%	37.2%	37.7%	-
	Ceftazidime	23.2%	20.5%*	18.3%*	21.1%	-
Fourth-generation cephalosporins	Cefepime	33.1%	29.4%	29.4%	25.2%	↘ p <0.01
Carbapenems	Ertapenem	0.5%	0.5%	0.6%	0.6%	-
	Imipenem	0.2%	0.4%	0.5%	0.3%	-
Other aminoglycosides	Gentamicin	35.3%	34.2%	32.7%	35.0%	-
	Amikacin	1.6%	1.3%	1.4%	0.8%	-
Fluoroquinolones	Levofloxacin‡	44.8%	39.5%	40.0%	46.1%	-

Legend: ↗ Increasing trend; ↘ Decreasing trend

* Non-susceptibility percentage should be interpreted with caution as the figure is derived from less than 70% of total isolates for surveillance. The figure may be affected by selection bias.

†P-value was calculated using Cochran-Armitage test, only trends with statistical significance ($p<0.05$) and high statistical significance ($p<0.01$) were reported

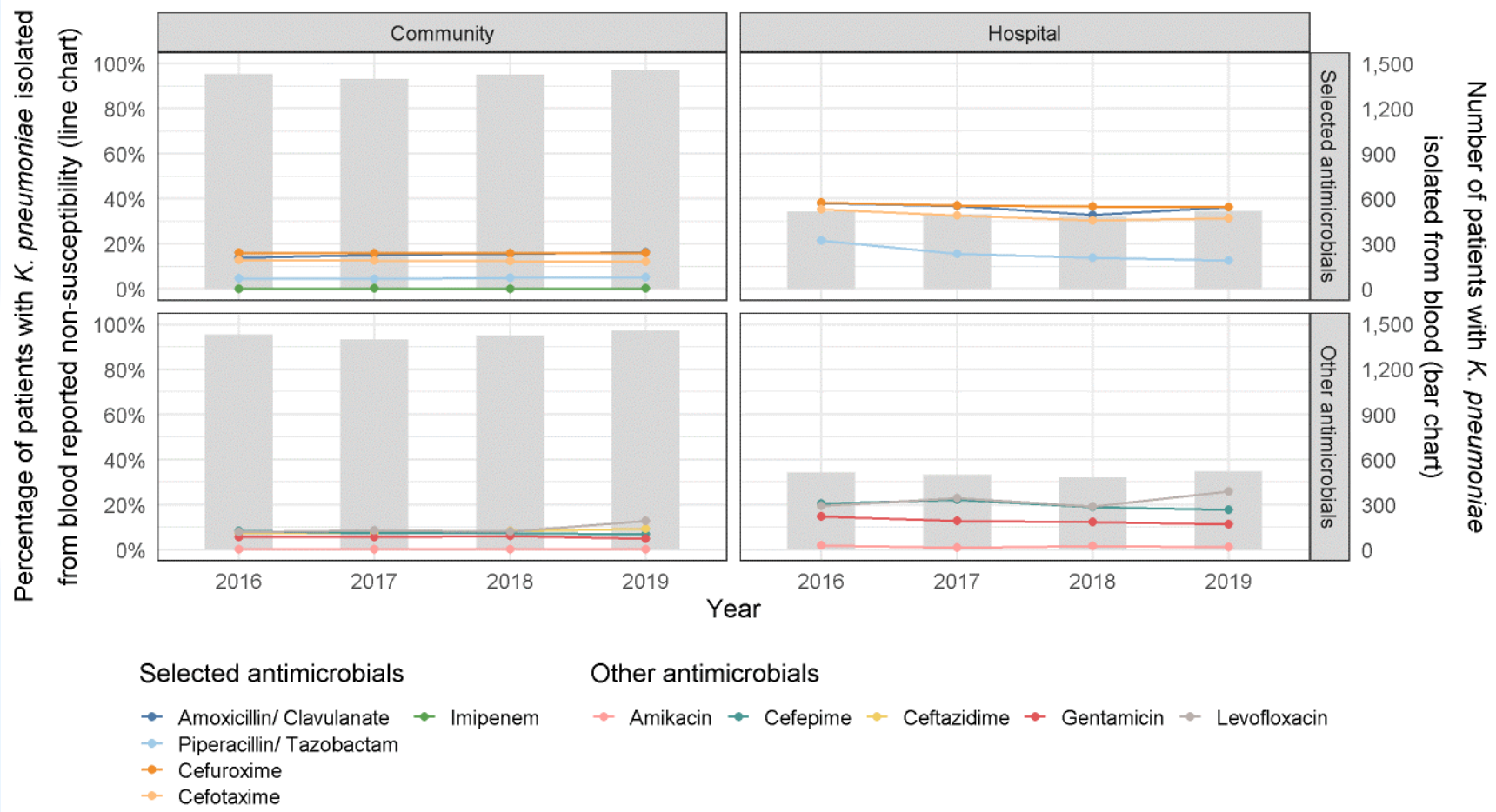
‡Revised levofloxacin interpretive criteria for Enterobacteriaceae (except *Salmonella* spp.) was released by CLSI in 2019. The increase in 2019 may be contributed by a change in CLSI criteria.

- Statistically significant results related to broad-spectrum antimicrobials
  - ⇩ trends towards piperacillin/tazobactam and cefepime

Results

3.2 AST results for *Klebsiella pneumoniae*

AST results for *K. pneumoniae* - Overview



- % NS to antimicrobials were lower among *K. pneumoniae* isolates of community-onset than those of hospital-onset

AST results for *K. pneumoniae* - 2018 vs 2019

Antimicrobial group	Antimicrobial (Big guns in yellow)	Community Onset			Hospital Onset		
		% NS		p-value†	% NS		p-value†
		2018	2019	18 vs 19	2018	2019	18 vs 19
Combinations of penicillins, incl. beta-lactamase inhibitors	Amoxicillin/ Clavulanate	15.6%	16.3%	-	33.0%	36.5%	-
	Piperacillin/ Tazobactam	5.1%	5.2%	-	13.8%	12.6%	-
Second-generation cephalosporins	Cefuroxime	15.8%	16.2%	-	36.6%	36.3%	-
Third-generation cephalosporins	Cefotaxime	12.5%	12.2%	-	30.5%	31.4%	-
	Ceftazidime	8.4%	9.4%	-	23.6%	24.0%	-
Fourth-generation cephalosporins	Cefepime	7.3%	6.8%	-	18.8%	17.8%	-
Carbapenems	Meropenem	0.1%*	0.6%	-	3.9%	2.7%	-
	Imipenem	0%	0.2%	-	-	-	-
Combinations of sulfonamides and trimethoprim, incl. derivatives	Co-trimoxazole	-	-	-	36.9%*	38.9%	-
Other aminoglycosides	Gentamicin	6.0%	4.9%	-	12.4%	11.3%	-
	Amikacin	0.1%	0.2%	-	1.7%	1.2%	-
Fluoroquinolones	Levofloxacin‡	8.0%	12.7%	<0.05	19.2%	25.9%	<0.05

* Non-susceptibility percentage should be interpreted with caution as the figure is derived from less than 70% of total isolates for surveillance. The figure may be affected by selection bias.
†P-value was calculated using chi-squared test or Fisher's exact test, whether appropriate
‡Revised levofloxacin interpretive criteria for Enterobacteriaceae (except *Salmonella* spp.) was released by CLSI in 2019. The increase in 2019 may be contributed by a change in CLSI criteria.

- No statistically significant results related to broad-spectrum antimicrobials

AST results for *K. pneumoniae* Trend 2016-2019 (Community Onset)

Antimicrobial group	Antimicrobial (Big guns in yellow)	Community Onset				
		% NS				p-value†
		2016	2017	2018	2019	2016 - 2019
Combinations of penicillins, incl. beta-lactamase inhibitors	Amoxicillin/ Clavulanate	13.9%	15.1%	15.6%	16.3%	↗ p <0.05
	Piperacillin/ Tazobactam	4.9%	4.6%	5.1%	5.2%	-
Second-generation cephalosporins	Cefuroxime	16.1%	16.0%	15.8%	16.2%	-
Third-generation cephalosporins	Cefotaxime	12.9%	12.6%	12.5%	12.2%	-
	Ceftazidime	7.3%	7.4%	8.4%	9.4%	↗ p <0.05
Fourth-generation cephalosporins	Cefepime	8.4%	7.3%	7.3%	6.8%	-
Carbapenems	Meropenem	0.4%*	0.3%*	0.1%*	0.6%	-
	Imipenem	0.2%	0.3%	0%	0.2%	-
Other aminoglycosides	Gentamicin	5.5%	5.5%	6.0%	4.9%	-
	Amikacin	0.3%	0.2%	0.1%	0.2%	-
Fluoroquinolones	Levofloxacin‡	7.9%	8.5%	8.0%	12.7%	↗ p <0.01

Legend: ↗ Increasing trend; ↘ Decreasing trend

* Non-susceptibility percentage should be interpreted with caution as the figure is derived from less than 70% of total isolates for surveillance. The figure may be affected by selection bias.

†P-value was calculated using Cochran-Armitage test, only trends with statistical significance ($p<0.05$) and high statistical significance ($p<0.01$) were reported

‡Revised levofloxacin interpretive criteria for Enterobacteriaceae (except *Salmonella* spp.) was released by CLSI in 2019. The increase in 2019 may be contributed by a change in CLSI criteria.

- Statistically significant results related to broad-spectrum antimicrobials
  - ⇧ trend towards ceftazidime

AST results for *K. pneumoniae*
Trend 2016-2019 (Hospital Onset)

Antimicrobial group	Antimicrobial (Big guns in yellow)	Hospital Onset				
		% NS				p-value†
		2016	2017	2018	2019	16 - 19
Combinations of penicillins, incl. beta-lactamase inhibitors	Amoxicillin/ Clavulanate	38.1%	36.8%	33.0%	36.5%	-
	Piperacillin/ Tazobactam	21.5%	15.6%	13.8%	12.6%	↘ p <0.01
Second-generation cephalosporins	Cefuroxime	38.4%	37.0%	36.6%	36.3%	-
Third-generation cephalosporins	Cefotaxime	35.4%	32.6%	30.5%	31.4%	-
	Ceftazidime	22.8%	25.4%*	23.6%	24.0%	-
Fourth-generation cephalosporins	Cefepime	20.3%	22.2%	18.8%	17.8%	-
Carbapenems	Meropenem	1.2%*	0.4%*	3.9%	2.7%	↗ p <0.05
	Imipenem	1.3%	0.5%	3.2%*	2.3%*	↗ p <0.05
Combinations of sulfonamides and trimethoprim, incl. derivatives	Co-trimoxazole	48.3%*	42.6%*	36.9%*	38.9%	↘ p <0.01
Other aminoglycosides	Gentamicin	14.6%	12.9%	12.4%	11.3%	-
	Amikacin	2.0%	1.0%	1.7%	1.2%	-
Fluoroquinolones	Levofloxacin‡	19.5%	22.8%	19.2%	25.9%	↗ p <0.05

Legend: ↗ Increasing trend; ↘ Decreasing trend

* Non-susceptibility percentage should be interpreted with caution as the figure is derived from less than 70% of total isolates for surveillance. The figure may be affected by selection bias.

†P-value was calculated using Cochran-Armitage test, only trends with statistical significance ($p<0.05$) and high statistical significance ($p<0.01$) were reported

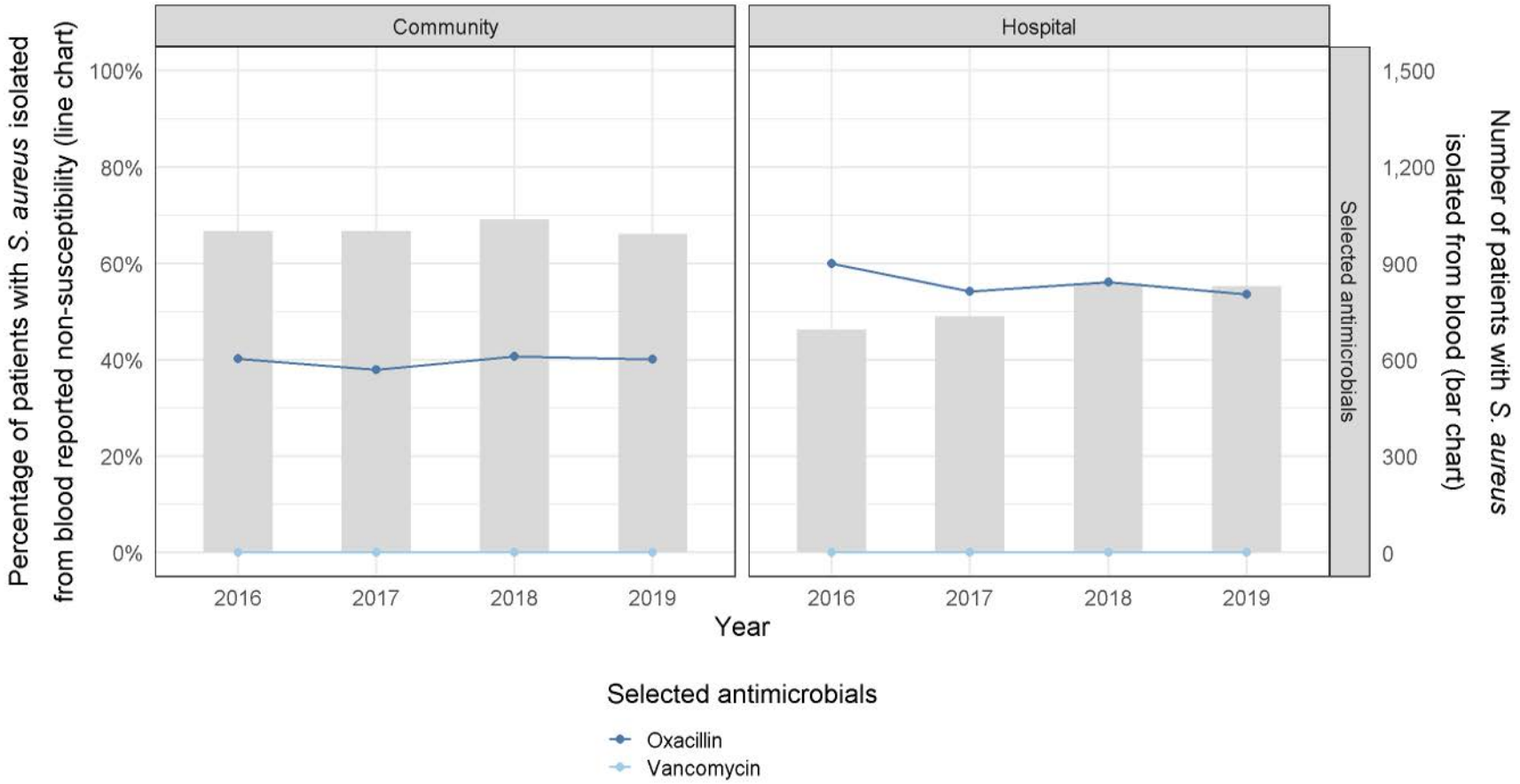
‡Revised levofloxacin interpretive criteria for Enterobacteriaceae (except *Salmonella* spp.) was released by CLSI in 2019. The increase in 2019 may be contributed by a change in CLSI criteria.

- Statistically significant results related to broad-spectrum antimicrobials
  - ⇧ trend towards meropenem and imipenem
  - ⇩ trend towards piperacillin/tazobactam

Results

3.3 AST results for *Staphylococcus aureus*

AST results for *S. aureus* - Overview



- % NS to oxacillin* for *S. aureus* isolates of hospital-onset higher than those of community-onset

* Sensitivity testing results of penicillinase stable penicillins (oxacillin, cloxacillin and methicillin) and cefoxitin towards *Staphylococcus aureus* were collectively grouped as "oxacillin" following the recommendation of CLSI

AST results for *S. aureus* - 2018 vs 2019

Antimicrobial group	Antimicrobial (Big guns in yellow)	Community Onset			Hospital Onset		
		% NS		p-value†	% NS		p-value†
		2018	2019	18 vs 19	2018	2019	18 vs 19
Beta-lactamase resistant penicillins	Oxacillin*	40.7%	40.1%	-	56.1%	53.6%	-
Glycopeptide antibacterials	Vancomycin	0%	0%	-	0%	0%	-

* Sensitivity testing results of penicillinase stable penicillins (oxacillin, cloxacillin and methicillin) and cefoxitin towards *Staphylococcus aureus* were collectively grouped as "oxacillin" following the recommendation of CLSI.
†P-value was calculated using chi-squared test or Fisher's exact test, whether appropriate

- None of the *S. aureus* isolates of community- and hospital-onset were found non-susceptible towards vancomycin

AST results for *S. aureus* Trend 2016-2019 (Community Onset)

Antimicrobial group	Antimicrobial (Big guns in yellow)	Community Onset % NS 2016	2017	2018	2019	p-value† 2016 - 2019
Beta-lactamase resistant penicillins	Oxacillin*	40.3%	37.9%	40.7%	40.1%	-
Glycopeptide antibacterials	Vancomycin	0%	0%	0%	0%	-

Legend: ↗ Increasing trend; ↘ Decreasing trend

* Sensitivity testing results of penicillinase stable penicillins (oxacillin, cloxacillin and methicillin) and cefoxitin towards *Staphylococcus aureus* were collectively grouped as "oxacillin" following the recommendation of CLSI

†P-value was calculated using Cochran-Armitage test, only trends with statistical significance ($p<0.05$) and high statistical significance ($p<0.01$) were reported

- None of the *S. aureus* isolates of community-onset were found non-susceptible towards vancomycin

AST results for *S. aureus*
Trend 2016-2019 (Hospital Onset)

Antimicrobial group	Antimicrobial (Big guns in yellow)	Hospital Onset				
		% NS				p-value†
		2016	2017	2018	2019	2016 - 2019
Beta-lactamase resistant penicillins	Oxacillin*	60.0%	54.2%	56.1%	53.6%	↘ p <0.05
Glycopeptide antibacterials	Vancomycin	0%	0%	0%	0%	-

Legend: ↗ Increasing trend; ↘ Decreasing trend

* Sensitivity testing results of penicillinase stable penicillins (oxacillin, cloxacillin and methicillin) and cefoxitin towards *Staphylococcus aureus* were collectively grouped as "oxacillin" following the recommendation of CLSI

†P-value was calculated using Cochran-Armitage test, only trends with statistical significance ($p<0.05$) and high statistical significance ($p<0.01$) were reported

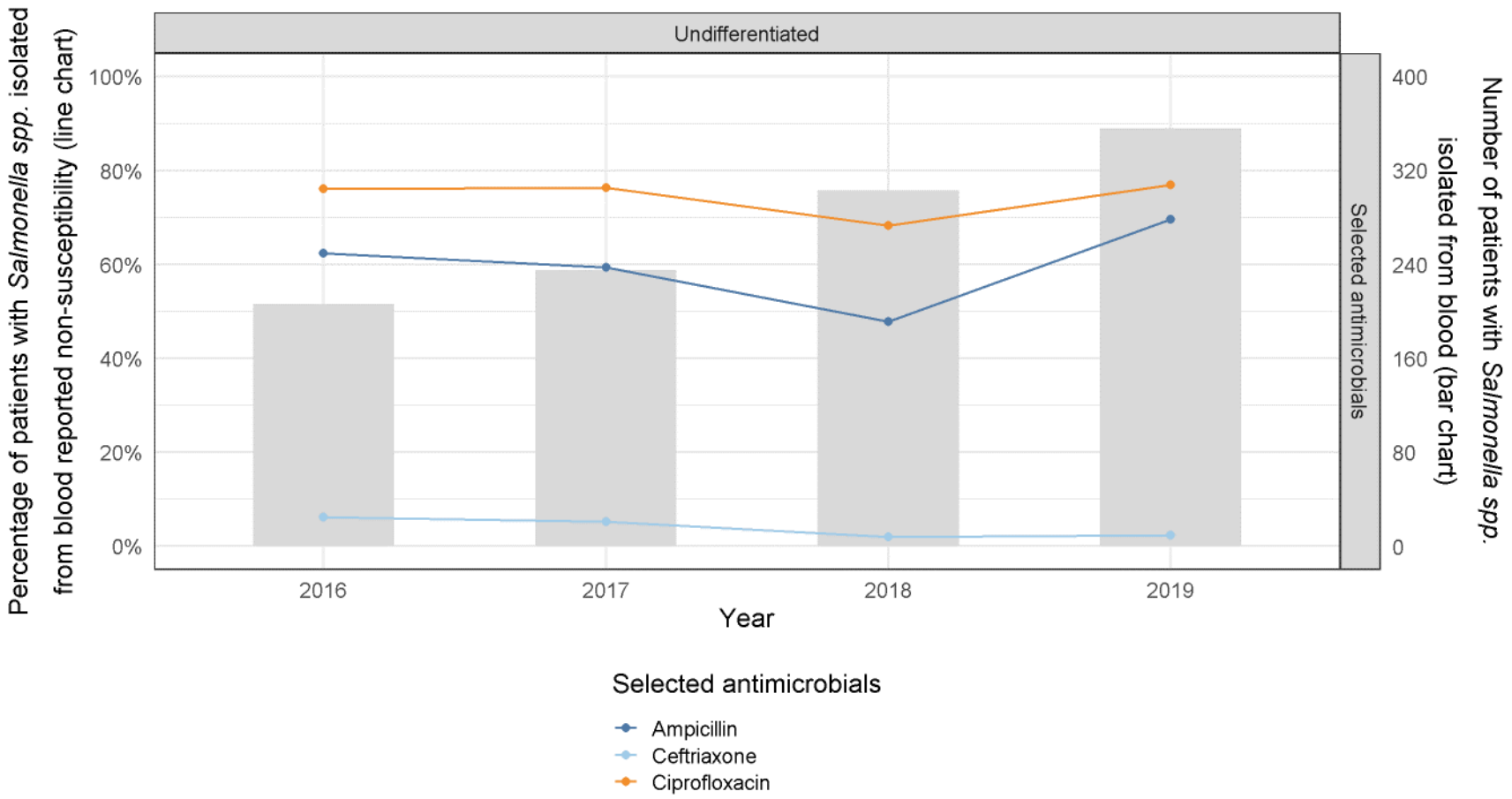
- None of the *S. aureus* isolates of hospital-onset were found non-susceptible towards vancomycin

Results

3.4 AST results for *Salmonella* spp.

Remarks: Only undifferentiated location of onset is reported for Salmonella spp.

AST results for *Salmonella* spp. - Overview



AST results for *Salmonella* spp. - 2018 vs 2019

Antimicrobial group	Antimicrobial (Big guns in yellow)	Community (Undifferentiated) Onset		
		% NS		p-value†
		2018	2019	18 vs 19
Penicillins with extended spectrum	Ampicillin	47.9%	69.7%	<0.05
Third-generation cephalosporins	Ceftriaxone	2.0%	2.3%	-
Fluoroquinolones	Ciprofloxacin	68.3%	76.9%	<0.05

†P-value was calculated using chi-squared test or Fisher's exact test, whether appropriate

- No statistically significant results related to broad-spectrum antimicrobials

AST results for *Salmonella* spp. Trend 2016-2019

Antimicrobial group	Antimicrobial (Big guns in yellow)	Community (Undifferentiated) Onset				
		% NS				p-value†
		2016	2017	2018	2019	2016 - 2019
Penicillins with extended spectrum	Ampicillin	62.4%	59.4%	47.9%	69.7%	-
Third-generation cephalosporins	Ceftriaxone	6.2%	5.2%	2.0%	2.3%	↘ p <0.01
Fluoroquinolones	Ciprofloxacin	76.1%	76.4%	68.3%	76.9%	-

Legend: ↗ Increasing trend; ↘ Decreasing trend

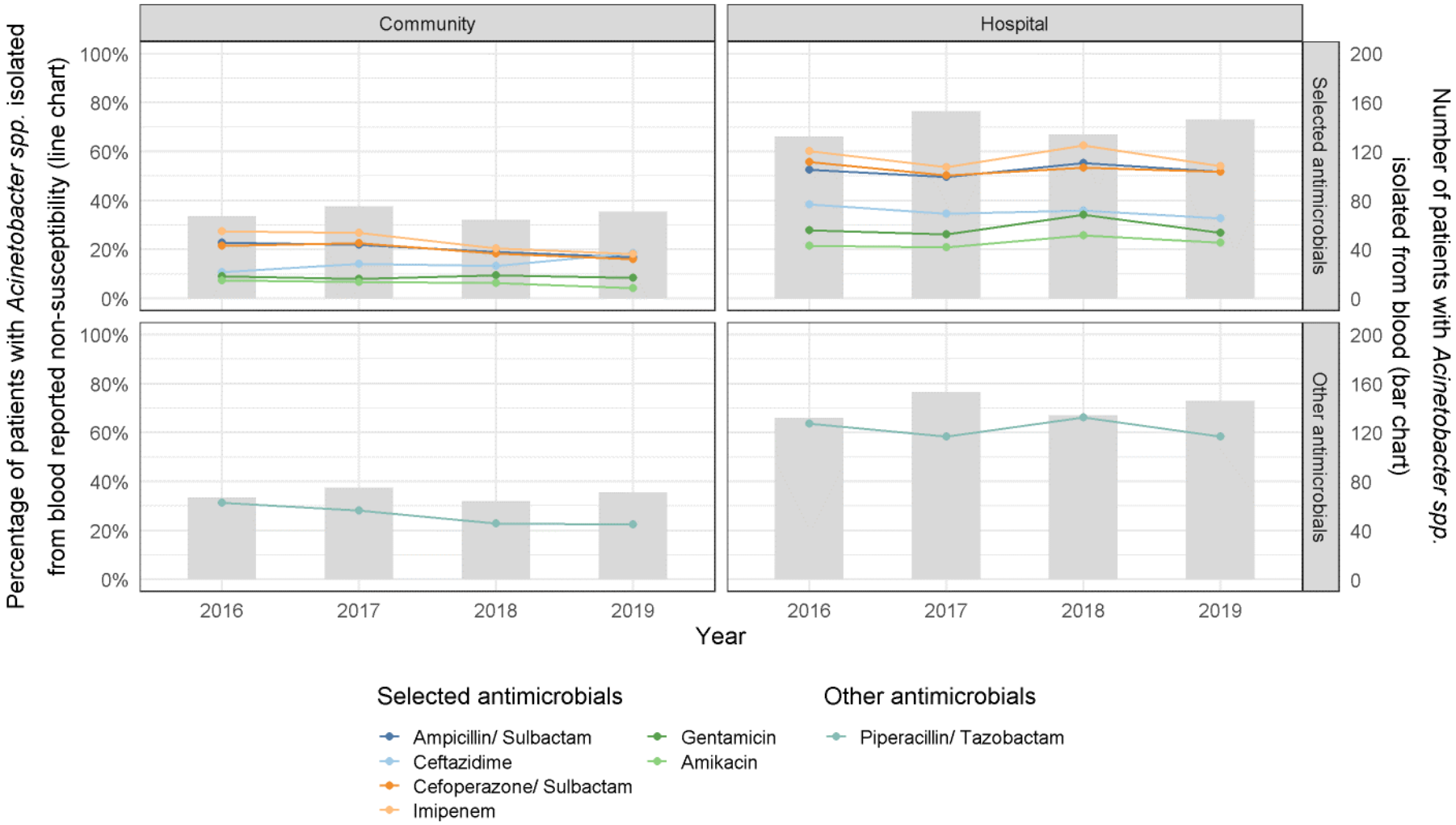
†P-value was calculated using Cochran-Armitage test, only trends with statistical significance ($p<0.05$) and high statistical significance ($p<0.01$) were reported

- No statistically significant results related to broad-spectrum antimicrobials

Results

3.5 AST results for *Acinetobacter* spp.

AST results for *Acinetobacter* spp. - Overview



- % NS were lower among *Acinetobacter* spp. isolates of community-onset than those of hospital-onset in general

AST results for Acinetobacter spp. - 2018 vs 2019

Antimicrobial group	Antimicrobial (Big guns in yellow)	Community Onset			Hospital Onset		
		% NS		p-value†	% NS		p-value†
		2018	2019	18 vs 19	2018	2019	18 vs 19
Combinations of penicillins, incl. beta-lactamase inhibitors	Ampicillin/ Sulbactam	19.0%	16.9%	-	55.4%	51.7%	-
	Piperacillin/ Tazobactam	23.0%	22.5%	-	66.2%	58.3%	-
Third-generation cephalosporins	Ceftazidime	13.3%	18.6%	-	35.9%	32.6%	-
	Cefoperazone/ Sulbactam	18.3%	15.9%	-	53.4%	51.8%	-
Fourth-generation cephalosporins	Cefepime	25.6%*	24.6%	-	62.2%*	58.6%	-
Carbapenems	Meropenem	26.3%*	22.0%	-	-	-	-
	Imipenem	20.4%	18.2%	-	62.5%	54.1%	-
Other aminoglycosides	Gentamicin	9.4%	8.5%	-	34.1%	26.9%	-
	Amikacin	6.3%	4.2%	-	25.8%	22.8%	-
Fluoroquinolones	Ciprofloxacin	24.3%*	25.0%	-	-	-	-
	Levofloxacin	28.6%	18.3%	-	57.7%	57.4%	-

* Non-susceptibility percentage should be interpreted with caution as the figure is derived from less than 70% of total isolates for surveillance. The figure may be affected by selection bias.

†P-value was calculated using chi-squared test or Fisher's exact test, whether appropriate

- No statistically significant results related to broad-spectrum antimicrobials

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AST results for *Acinetobacter* spp. Trend 2016-2019 (Community-Onset)

Antimicrobial group	Antimicrobial (Big guns in yellow)	Community Onset				
		% NS				p-value†
		2016	2017	2018	2019	2016 - 2019
Combinations of penicillins, incl. beta-lactamase inhibitors	Ampicillin/ Sulbactam	22.8%	21.9%	19.0%	16.9%	-
	Piperacillin/ Tazobactam	31.3%	28.2%	23.0%	22.5%	-
Third-generation cephalosporins	Ceftazidime	10.8%	14.1%	13.3%	18.6%	-
	Cefoperazone/ Sulbactam	21.5%	22.5%	18.3%	15.9%	-
Fourth-generation cephalosporins	Cefepime	25.8%*	28.6%*	25.6%*	24.6%	-
Carbapenems	Meropenem	33.3%*	28.9%*	26.3%*	22.0%	-
	Imipenem	27.4%	26.9%	20.4%	18.2%	-
Other aminoglycosides	Gentamicin	9.0%	8.0%	9.4%	8.5%	-
	Amikacin	7.5%	6.7%	6.3%	4.2%	-
Fluoroquinolones	Ciprofloxacin	27.1%	32.1%	24.3%*	25.0%	-
	Levofloxacin	23.3%*	25.5%*	28.6%	18.3%	-

Legend: ↗ Increasing trend; ↘ Decreasing trend

* Non-susceptibility percentage should be interpreted with caution as the figure is derived from less than 70% of total isolates for surveillance. The figure may be affected by selection bias.

†P-value was calculated using Cochran-Armitage test, only trends with statistical significance ($p<0.05$) and high statistical significance ($p<0.01$) were reported

- No statistically significant results related to broad-spectrum antimicrobials

AST results for *Acinetobacter* spp. Trend 2016-2019 (Hospital-onset)

Antimicrobial group	Antimicrobial (Big guns in yellow)	Hospital Onset				
		% NS				p-value†
		2016	2017	2018	2019	2016 - 2019
Combinations of penicillins, incl. beta-lactamase inhibitors	Ampicillin/ Sulbactam	52.5%	49.7%	55.4%	51.7%	-
	Piperacillin/ Tazobactam	63.6%	58.3%	66.2%	58.3%	-
Third-generation cephalosporins	Ceftazidime	38.4%	34.7%	35.9%	32.6%	-
	Cefoperazone/ Sulbactam	55.6%	50.3%	53.4%	51.8%	-
Fourth-generation cephalosporins	Cefepime	67.2%*	71.8%*	62.2%*	58.6%	-
Carbapenems	Imipenem	60.2%	53.6%	62.5%	54.1%	-
Other aminoglycosides	Gentamicin	27.9%	26.2%	34.1%	26.9%	-
	Amikacin	21.5%	20.8%	25.8%	22.8%	-
Fluoroquinolones	Levofloxacin	55.7%*	55.2%*	57.7%	57.4%	-

Legend: ↗ Increasing trend; ↘ Decreasing trend

* Non-susceptibility percentage should be interpreted with caution as the figure is derived from less than 70% of total isolates for surveillance. The figure may be affected by selection bias.

†P-value was calculated using Cochran-Armitage test, only trends with statistical significance ($p<0.05$) and high statistical significance ($p<0.01$) were reported

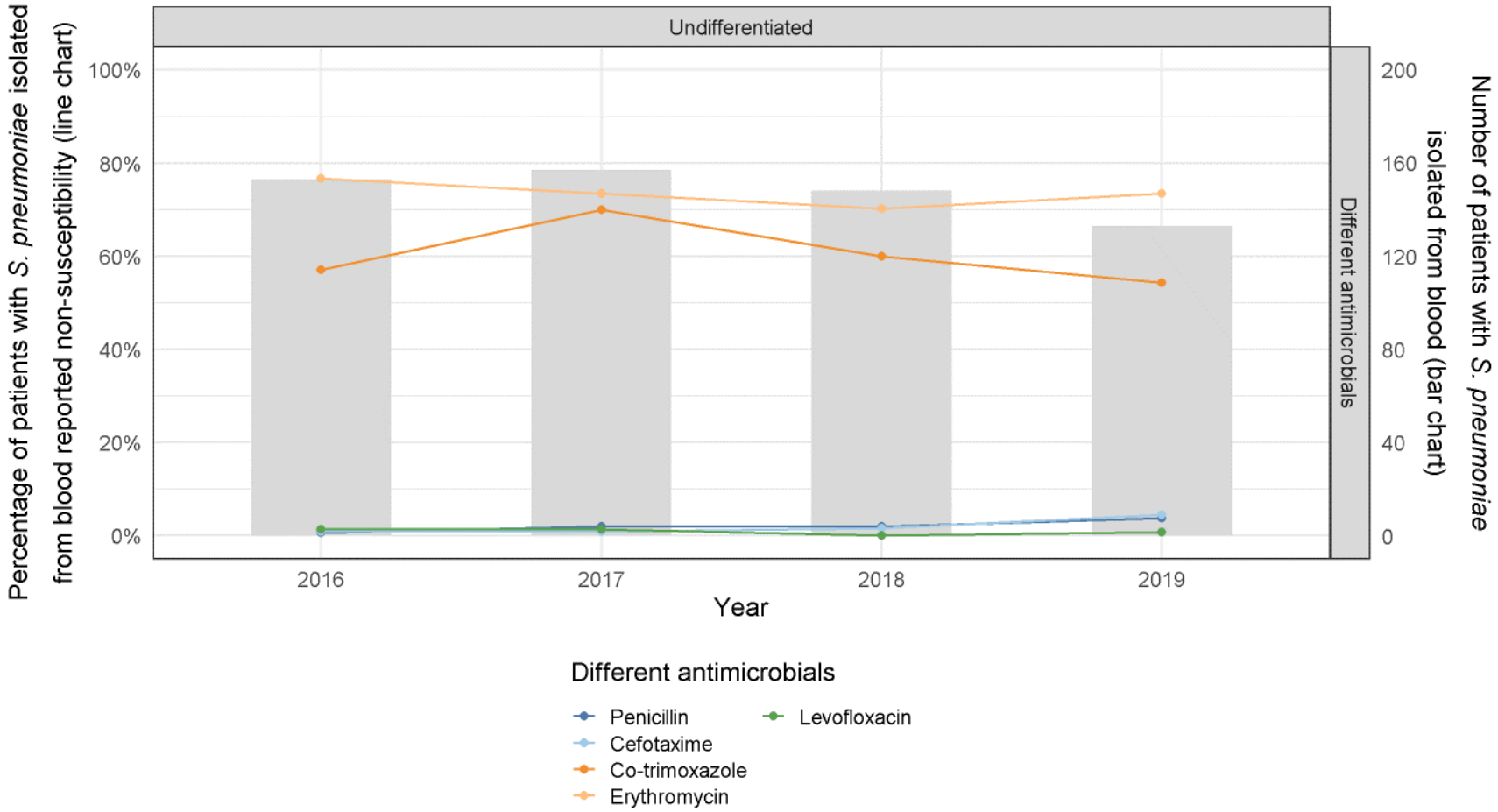
- No statistically significant results related to broad-spectrum antimicrobials

Results

3.6 AST results for *Streptococcus pneumoniae*

Remarks: Only undifferentiated location of onset is reported for Streptococcus pneumoniae

AST results for *Streptococcus pneumoniae* - Overview



AST results for *Streptococcus pneumoniae* – 2018 vs 2019

		Community (Undifferentiated) Onset		
		% NS		p-value†
Antimicrobial group	**Antimicrobial**	**2018**	**2019**	**18 vs 19**
Beta-lactam antibacterials, penicillins	Penicillin	2.0%	3.8%	-
Third-generation cephalosporins	Cefotaxime	1.6%	4.5%	-
Combinations of sulfonamides and trimethoprim, incl. derivatives	Co-trimoxazole	60.0%	54.3%	-
Macrolides	Erythromycin	70.2%	73.5%	-
Fluoroquinolones	Levofloxacin	0%	0.8%	-

†P-value was calculated using chi-squared test or Fisher's exact test, whether appropriate

- No statistically significant results observed

AST results for *Streptococcus pneumoniae* Trend 2016-2019

		Community (Undifferentiated) Onset				
		% NS				p-value†
Antimicrobial group	**Antimicrobial**	**2016**	**2017**	**2018**	**2019**	**2016 - 2019**
Beta-lactam antibacterials, penicillins	Penicillin	0.7%	2.0%	2.0%	3.8%	↗ p <0.05
Third-generation cephalosporins	Cefotaxime	0.9%	0.9%	1.6%	4.5%	↗ p <0.05
Combinations of sulfonamides and trimethoprim, incl. derivatives	Co-trimoxazole	57.0%	70.0%	60.0%	54.3%	-
Macrolides	Erythromycin	76.8%	73.4%	70.2%	73.5%	-
Fluoroquinolones	Levofloxacin	1.3%	1.3%	0%	0.8%	-

Legend: ↗ Increasing trend; ↘ Decreasing trend

†P-value was calculated using Cochran-Armitage test, only trends with statistical significance ($p<0.05$) and high statistical significance ($p<0.01$) were reported

- % NS of *Streptococcus pneumoniae* isolates towards penicillin and cefotaxime showed an increasing trend with statistical significance

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Remarks on Interpretation of Results

- Differentiation of location of onset of patients with bloodstream infections for surveillance purposes depends on the operational definition (hospital-onset for organism isolated from blood specimen collected > 48 hours after hospital admission):
  - Factors affecting differentiation of location of onset:
    - Timing of blood specimen taken
    - Rate of disease progression
- CLSI guidelines for sensitivity testing involving levofloxacin interpretive criteria for Enterobacteriaceae (except *Salmonella* spp.) has been updated in 2019. For laboratories that chose to apply the new criteria for reporting in 2019, some *E. coli* and *K. pneumoniae* isolates previously categorised as susceptible to levofloxacin would be categorised as non-susceptible using the updated zone size requirement under the 2019 criteria.
- Laboratories of different hospitals might use different panels for AST. This could result in bias of results toward those laboratories performing a major proportion of a particular AST especially if number of isolates tested is small.
  - In the report, the issue of small number of isolates is partially addressed, in accordance of recommendation by WHO GLASS, that non-susceptibility results derived from <10 isolates were not included for analysis.

Summary Table on Key Findings

	Community-onset	Hospital-onset
Escherichia coli	↘ Piperacillin/tazobactam ↘ Cefepime	↘ Piperacillin/tazobactam ↘ Cefepime
Klebsiella pneumoniae	↗ Ceftazidime	↘ Piperacillin/tazobactam ↗ Meropenem ↗ Imipenem
Staphylococcus aureus	(None observed)	(None observed)
Acinetobacter spp.	(None observed)	(None observed)

	Community (Undifferentiated)-onset
Salmonella spp.	(None observed)
Streptococcus pneumoniae	↗ Penicillin ↗ Cefotaxime

Legend: ↗ Increasing trend; ↘ Decreasing trend; Red = big guns

Summary

- In general, trend of % NS on majority of selected antimicrobials for the six WHO GLASS priority pathogens remains stable or decreasing during 2016 to 2019
- Increasing trends of % NS with statistical significance were observed amongst the following antimicrobial – organism combinations:
  - *Klebsiella pneumoniae* (hospital-onset) towards **meropenem** and **imipenem**
  - *Klebsiella pneumoniae* (community-onset) towards **ceftazidime**
  - *Streptococcus pneumoniae* (community (undifferentiated) onset) towards **penicillin** and **cefotaxime**

Recommendations

- In view of increasing trend of % NS of the following broad-spectrum antimicrobial – organism combination, further monitoring is warranted. In particular, dispensing quantity of meropenem showed a compound annual growth rate of 10.16%* from 2016 to 2019
  - *Klebsiella pneumoniae* (hospital-onset) towards **meropenem** and **imipenem**
- To alert working partners of HA about increasing trend of non-susceptibility of the aforesaid broad-spectrum antimicrobial – organism combination for their further investigation and management as appropriate. Priority could be given to non-susceptibility of meropenem for hospital-onset *K. pneumoniae*
- Further exploration with subgroup analysis as a separate exercise in future could be conducted to identify age, gender and specialty of patient population which are more likely to carry the non-susceptible organisms

*In terms of DDD per 1000 patient-days

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THE END

Thank you

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