

# **Current Situation & Challenges of Antimicrobial-resistant Bacteria in Vietnam**

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# Vietnam healthcare system

- Vietnam had ~1,085 hospitals with 308,400 patient beds<sup>1</sup>
  - Provincial hospital: ~ 500 (380-700) beds with 36,926 admission/year<sup>2</sup>
  - District hospitals: 146 (110–212) beds with 8362 admission/year<sup>2</sup>
- ~53% patients admitted to critical care units with diagnosis of infection<sup>3</sup>



1. <https://doi.org/10.1371/journal.pone.0240830>

2. <https://doi.org/10.1016/j.jcrc.2017.07.020>

3. <http://dx.doi.org/10.1136/bmjopen-2022-061638>

# Antibiotic resistance threats in Vietnam

Antibiotic-resistant microorganism	Vietnam
Priority 1: CRITICAL	
• Acinetobacter baumannii, carbapenem-resistant	51-93% <sup>1</sup>
• Pseudomonas aeruginosa, carbapenem-resistant	42.9-86.2% <sup>1</sup>
• Enterobacteriaceae, carbapenem-resistant, ESBL-producing	2-55% <sup>1</sup>
Priority 2: HIGH	
• Enterococcus faecium, vancomycin-resistant	-
• Staphylococcus aureus, methicillin-resistant, vancomycin-intermediate and resistant	7.9-67.4% <sup>2</sup>
• Helicobacter pylori, clarithromycin-resistant	72.6% <sup>3</sup>
• Campylobacter spp., fluoroquinolone-resistant	-
• Salmonellae, fluoroquinolone-resistant	8.6% <sup>4</sup>
• Neisseria gonorrhoeae, cephalosporin-resistant, fluoroquinolone-resistant	54% (ciprofloxacin) <sup>5</sup>
Priority 3: MEDIUM	
• Streptococcus pneumoniae, penicillin-non-susceptible	93.6% <sup>6</sup>
• Haemophilus influenzae, ampicillin-resistant	64.1% <sup>7</sup>
• Shigella spp., fluoroquinolone-resistant	7.6% <sup>8</sup>

1. <https://doi.org/10.21954/ou.ro.00011239>  
 2. <https://doi.org/10.3889/oamjms.2019.871>  
 3. <https://doi.org/10.1016/j.jgar.2020.06.007>  
 4. <https://doi.org/10.1128/JCM.01465-20>  
 5. <https://doi.org/10.1093/cid/ciz365>  
 6. <https://doi.org/10.1093/jac/dkaa276>  
 7. <https://doi.org/10.1093/jac/dkw069>  
 8. <https://doi.org/10.1093/jac/dkv400>



# High economic burden of treating resistant pathogens

- Cost of antibiotic treatment comprising 51.1% of the total cost
- The average daily cost of antibiotic to treat carbapenem resistant Gram-negative bacteria was US\$ 172 versus US\$ 28.3 to treat carbapenem susceptible Gram-negative bacteria.

# Contributors to antibiotic resistance

- Dispensing antibiotics without prescription in community
  - **88-91%** of antibiotics were sold **without a prescription**<sup>1</sup>
- Inappropriate use of antibiotics in hospitals
  - one-third of inpatients had an inappropriate antibiotic during their admission<sup>2</sup>
  - Expenditure on systemic antibacterials and antifungals accounted
    - **~ 30%** of the **total drug bids** in public hospitals<sup>3</sup>



1. <https://doi.org/10.1186/2050-6511-15-6>
2. <https://doi.org/10.1016/j.ajic.2011.10.020>
3. <https://doi.org/10.1371/journal.pone.0240830>

# The WHO AWaRe (Access, Watch, Reserve) Classification of Antibiotics

## ACCESS

Antibiotics that represent first or second-line for empirical treatment of common infectious syndromes based on a systematic assessment of the available evidence and that have a favorable safety profile with a low propensity to further aggravate AMR. All Access antibiotics are part of the EML core list, meaning that these antibiotics should be widely available in all settings (while still making efforts to ensure their appropriate use). Many penicillins belong to this class.

## WATCH

Antibiotics that present a higher potential to negatively impact AMR. Some Watch group antibiotics are also included in the EML core list since they are the most effective options for a limited group of well-defined clinical syndromes, but their use should be tightly monitored and restricted to the limited indications. Fluoroquinolones, which are unfortunately commonly used in many settings, belong to the Watch group as their use should be avoided for indications for which they are no longer first or second choice.

## RESERVE

"Last-resort" antibiotics, that have activity against multi (MDR)- or extensively (XDR) resistant bacteria, and therefore represent a valuable, non-renewable resource that should be used as sparingly as possible. Some of the newly approved antibiotics (e.g. ceftazidime-avibactam) fall into this class, as do some of the older "rediscovered" antibiotics (e.g. polymyxins).

## ACCESS

**Aminocyclitols:**  
Spectinomycin

**Aminoglycosides:**  
Amikacin  
Gentamicin

**Amphenicols:**  
Chloramphenicol  
Thiamphenicol

**Beta-lactam/ beta-lactamase-inhibitor:**  
Amoxicillin/clavulanic-acid  
Ampicillin/sulbactam  
Sultamicillin

**Beta-lactamase-inhibitors:**  
Sulbactam

**First-generation-cephalosporins:**  
Cefacetrile  
Cefadroxil  
Cefalexin  
Cefaloridine  
Cefalotin  
Cefapirin  
Cefatrizine  
Cefazedone  
Cefazolin  
Cefradine  
Cefroxadine  
Ceftazole

**Imidazoles:**  
Metronidazole\_IV  
Metronidazole\_oral  
Ornidazole\_IV  
Ornidazole\_oral  
Secnidazole  
Tinidazole\_IV  
Tinidazole\_oral

**Lincosamides:**  
Clindamycin

**Nitrofurans derivatives:**  
Furazidin  
Nifurtinol

**Nitrofurans-derivatives:**  
Nitrofurantoin

**Sulfonamide-trimethoprim combinations:**  
Sulfadiazine/tetroxoprim  
Sulfadiazine/trimethoprim  
Sulfadimidine/trimethoprim  
Sulfamerazine/trimethoprim  
Sulfamethoxazole/trimethoprim  
Sulfametrole/trimethoprim  
Sulfamoxole/trimethoprim

**Penicillins:**  
Amoxicillin  
Ampicillin  
Azidocillin  
Bacampicillin  
Benzathine-benzylpenicillin  
Benzylpenicillin  
Clometocillin  
Cloxacillin  
Dicloxacillin  
Epicillin  
Flucloxacillin  
Hetacillin  
Mecillinam  
Metampicillin  
Meticillin  
Nafcillin  
Oxacillin  
Penamocillin  
Phenoxymethylpenicillin  
Pivampicillin  
Pivmecillinam  
Procaine-benzylpenicillin  
Propicillin  
Talampicillin

**Sulfonamides:**  
Sulfadiazine  
Sulfadimethoxine  
Sulfadimidine  
Sulfafurazole  
Sulfaisodimidine  
Sulfalene  
Sulfamazole  
Sulfamerazine  
Sulfamethizole  
Sulfamethoxazole  
Sulfamethoxypyridazine  
Sulfametomidine  
Sulfametoxydiazine  
Sulfamoxole  
Sulfanilamide  
Sulfaperin  
Sulfaphenazole  
Sulfapyridine  
Sulfathiazole  
Sulfathiourea

**Tetracyclines:**  
Doxycycline  
Tetracycline

**Trimethoprim-derivatives:**  
Brodiprim  
Trimethoprim

**Aminoglycosides:**  
Arbekacin  
Bekanamycin  
Dibekacin  
Isepamicin  
Kanamycin\_IV  
Kanamycin\_oral  
Micronomicin  
Neomycin\_IV  
Neomycin\_oral  
Netilmicin  
Ribostamycin  
Sisomicin  
Streptoduocin  
Streptomycin\_IV  
Streptomycin\_oral  
Tobramycin

**Beta-lactam/beta-lactamase-inhibitor\_anti-pseudomonal:**  
Piperacillin/tazobactam

**Beta-lactamase-inhibitors:**  
Tazobactam

**Carbapenems:**  
Biapenem  
Doripenem  
Ertapenem  
Imipenem/cilastatin  
Meropenem  
Panipenem  
Tebipenem

**Fluoroquinolones:**  
Ciprofloxacin  
Delafloxacin  
Enoxacin  
Fleroxacin  
Garenoxacin  
Gatifloxacin  
Gemifloxacin  
Grepafloxacin  
Lascufloxacin  
Levofloxacin  
Levonadifloxacin  
Lomefloxacin  
Moxifloxacin  
Norfloxacin  
Ofloxacin  
Pazufloxacin  
Pefloxacin  
Prulifloxacin  
Rufloxacin  
Sitafloxacin  
Sparfloxacin  
Temafoxacin  
Tosufloxacin  
Trovafoxacin

## WATCH

**Fourth-generation-cephalosporins:**  
Cefepime  
Cefoselis  
Cefozopran  
Cefpirome

**Glycopeptides:**  
Teicoplanin  
Vancomycin\_IV  
Vancomycin\_oral

**Lincosamides:**  
Lincomycin

**Macrolides:**  
Azithromycin  
Clarithromycin  
Dirithromycin  
Erythromycin  
Flurithromycin  
Josamycin  
Midecamycin  
Mioamycin  
Oleandomycin  
Rokitamycin  
Roxithromycin  
Solithromycin  
Spiramycin  
Telithromycin  
Troleandomycin

**Penicillins:**  
Aspoxicillin  
Azlocillin  
Carbencillin  
Carindacillin  
Mezlocillin  
Pheneticillin  
Piperacillin  
Sulbenicillin  
Temocillin  
Ticarcillin

**Phenol derivatives:**  
Clofectol

**Phosphonics:**  
Fosfomicin\_oral

**Quinolones:**  
Cinoxacin  
Flumequine  
Nemonoxacin  
Oxolinic-acid  
Pipemidic-acid  
Piromidic-acid  
Rosoxacin

**Rifamycins:**  
Rifabutin  
Rifampicin  
Rifamycin\_IV  
Rifamycin\_oral  
Rifaximin

**Second-generation-cephalosporins:**  
Cefaclor  
Cefamandole  
Cefbuperazone  
Cefmetazole  
Cefminox  
Cefonicid  
Ceforanide  
Cefotetan  
Cefotiam  
Cefoxitin  
Cefprozil  
Cefuroxime  
Flomoxef  
Loracarbef

**Steroid antibacterials:**  
Fusidic-acid

**Streptogramins:**  
Pristinamycin

**Tetracyclines:**  
Chlortetracycline  
Clomocycline  
Demeclocycline  
Lymecycline  
Metacycline  
Minocycline\_oral  
Oxytetracycline  
Penimepicycline  
Rolitetracycline  
Sarecycline

**Third-generation-cephalosporins:**  
Cefcapene-pivoxil  
Cefdinir  
Cefditoren-pivoxil  
Cefetamet-pivoxil  
Cefixime  
Cefmenoxime  
Cefodizime  
Cefoperazone  
Cefotaxime  
Cefpiramide  
Cefpodoxime-proxetil  
Cefsulodin  
Ceftazidime  
Ceftaravim-pivoxil  
Ceftibuten  
Ceftizoxime  
Ceftriaxone  
Latamoxef

## RESERVE

**Aminoglycosides:**  
Plazomicin

**Carbapenems:**  
Imipenem/cilastatin/relebactam  
Meropenem/vaborbactam

**Fifth-generation cephalosporins:**  
Ceftaroline-fosamil  
Ceftobiprole-medocartil  
Ceftolozane/tazobactam

**Glycopeptides:**  
Dalbavancin  
Oritavancin  
Telavancin

**Glycylcyclines:**  
Tigecycline

**Lipopeptides:**  
Daptomycin

**Monobactams:**  
Aztreonam  
Carumonam

**Other-cephalosporins:**  
Cefiderocol

**Oxazolidinones:**  
Linezolid  
Tedizolid

**Penems:**  
Faropenem

**Phosphonics:**  
Fosfomicin\_IV

**Pleuromutilin:**  
Lefamulin

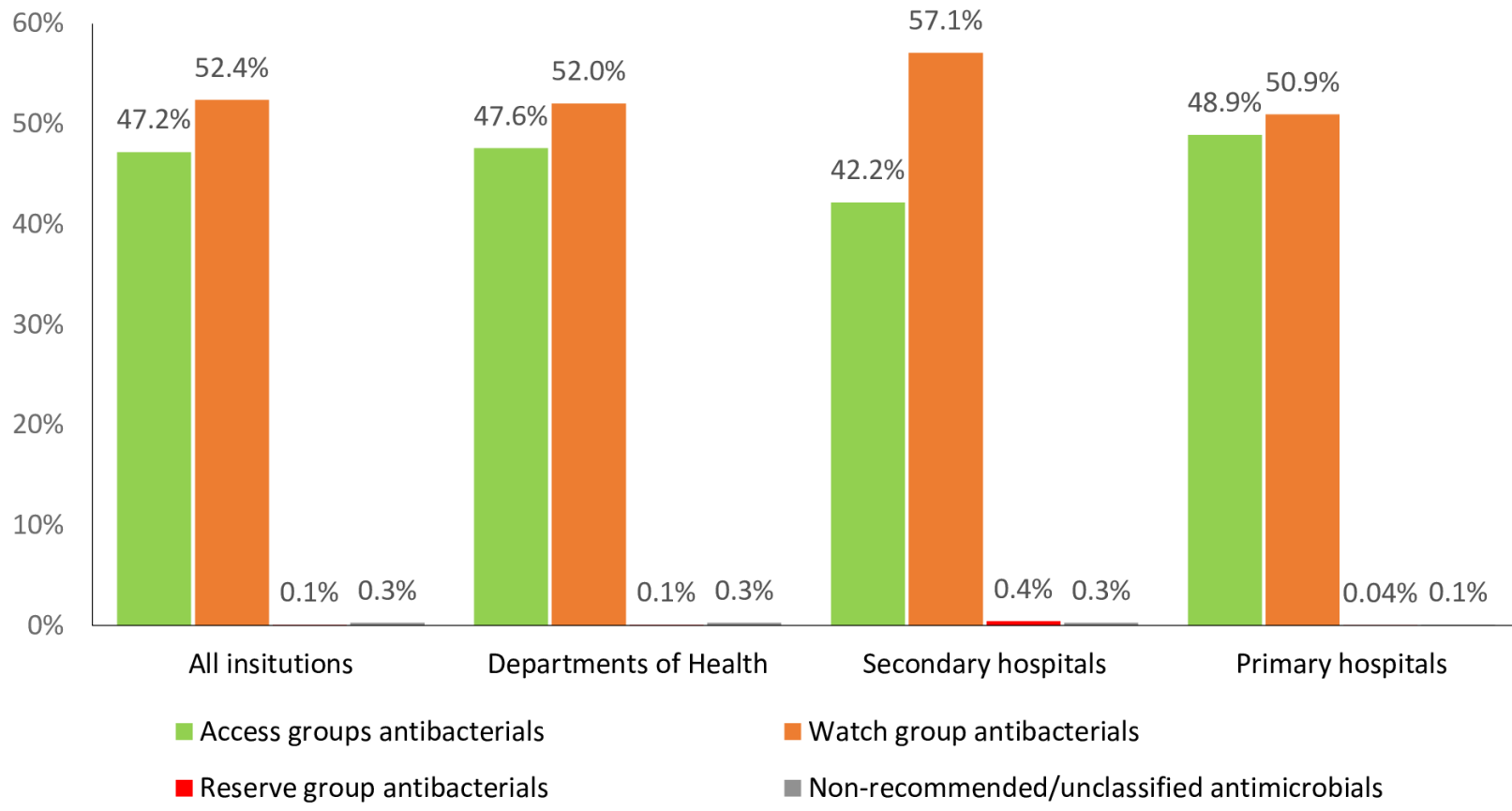
**Polymyxins:**  
Colistin\_IV  
Colistin\_oral  
Polymyxin-B\_IV  
Polymyxin-B\_oral

**Streptogramins:**  
Daifopristin/quinupristin

**Tetracyclines:**  
Eravacycline  
Minocycline\_IV  
Omadacycline

**Third-generation-cephalosporins:**  
Ceftazidime/avibactam

**Trimethoprim-derivatives:**  
Iclaprim



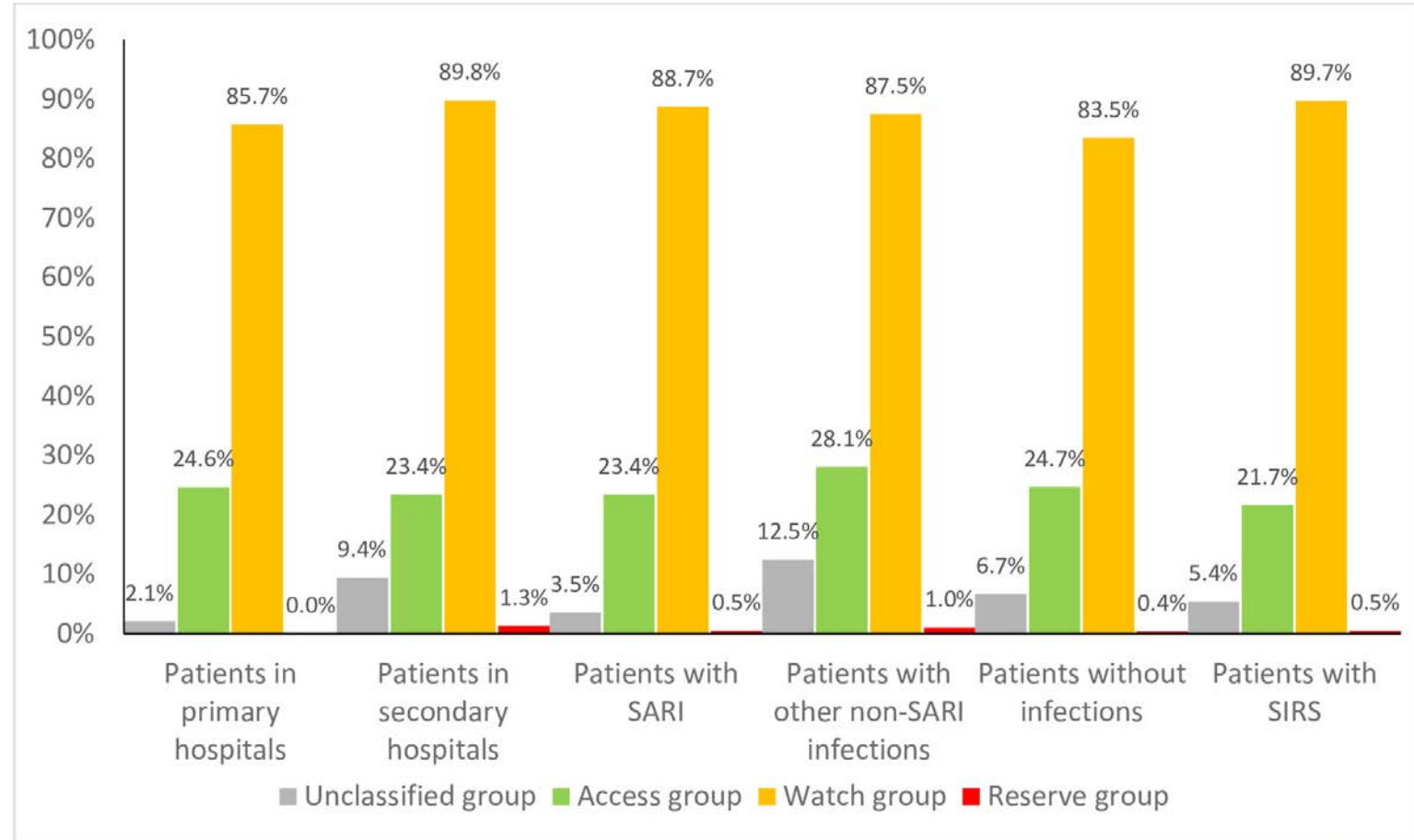
Dat VQ, Toan PK, van Doorn HR, Thwaites CL, Nadjm B (2020) Purchase and use of antimicrobials in the hospital sector of Vietnam, a lower middle-income country with an emerging pharmaceuticals market. PLoS ONE 15(10): e0240830. <https://doi.org/10.1371/journal.pone.0240830>

	Department of Health		Secondary hospitals		Primary hospitals		All sites	
	% DDD	% expenditure	% DDD	% expenditure	% DDD	% expenditure	% DDD	% expenditure
J01DC_Second generation cephalosporins	20.29%	16.52%	19.66%	8.06%	21.81%	15.87%	20.25%	15.67%
J01CR_Combinations of penicillins, incl. beta lactamase inhibitors	16.31%	15.77%	26.33%	15.22%	18.35%	24.10%	17.06%	15.74%
J01CA_Penicillins with extended spectrum	15.78%	2.94%	10.67%	0.91%	11.89%	2.21%	15.38%	2.74%
J01DD_Third generation cephalosporins	12.23%	23.02%	19.73%	23.31%	8.55%	24.86%	12.77%	23.05%
J01MA_Fluoroquinolones	11.33%	11.56%	12.89%	14.89%	11.54%	7.94%	11.45%	11.89%
J01DB_First generation cephalosporins	9.00%	8.16%	0.80%	0.57%	15.00%	8.52%	8.43%	7.40%
J01FA_Macrolides	8.22%	3.41%	4.05%	1.31%	9.20%	8.81%	7.91%	3.22%
J01AA_Tetracyclines	1.79%	0.07%	1.78%	0.47%	2.13%	0.08%	1.79%	0.11%
J01CE_Beta lactamase sensitive penicillins	1.59%	0.08%	0.07%	0.00%	0.39%	0.03%	1.47%	0.07%
J01EA_Trimethoprim and derivatives	0.97%	0.18%	0.22%	0.01%	0.11%	0.01%	0.91%	0.16%
J01GB_Other aminoglycosides	0.86%	1.63%	1.45%	1.27%	0.72%	0.84%	0.90%	1.59%
J01XD_Imidazole derivatives	0.40%	1.29%	0.48%	0.81%	0.05%	0.22%	0.40%	1.24%
J01CF_Beta lactamase resistant penicillins	0.39%	0.90%	0.18%	0.29%	0.05%	0.13%	0.37%	0.83%
J01FF_Lincosamides	0.22%	0.74%	0.22%	0.93%	0.00%	0.00%	0.22%	0.76%
J01DH_Carbapenems	0.18%	9.18%	0.50%	18.74%	0.04%	1.27%	0.20%	10.12%
J01DE_Fourth generation cephalosporins	0.15%	2.25%	0.29%	3.43%	0.05%	2.04%	0.16%	2.37%
J01MB_Other quinolones	0.14%	0.05%	0.01%	0.00%	0.04%	0.04%	0.13%	0.05%
J01XX_Other antibacterials	0.05%	0.69%	0.37%	3.09%	0.04%	0.76%	0.08%	0.93%
J01XA_Glycopeptide antibacterials	0.05%	0.69%	0.23%	2.78%	0.03%	1.05%	0.06%	0.90%
J01BA_Amphenicols	0.03%	0.03%	0.00%	0.00%	0.01%	0.01%	0.03%	0.02%
J01XB_Polymyxins	0.01%	0.84%	0.07%	3.90%	0.01%	1.19%	0.02%	1.15%

The cells were colorized with red-yellow-green color scale by column. The highest values in a column were red, the average values were yellow, and the lowest values were green. DDD = Defined Daily Dose.

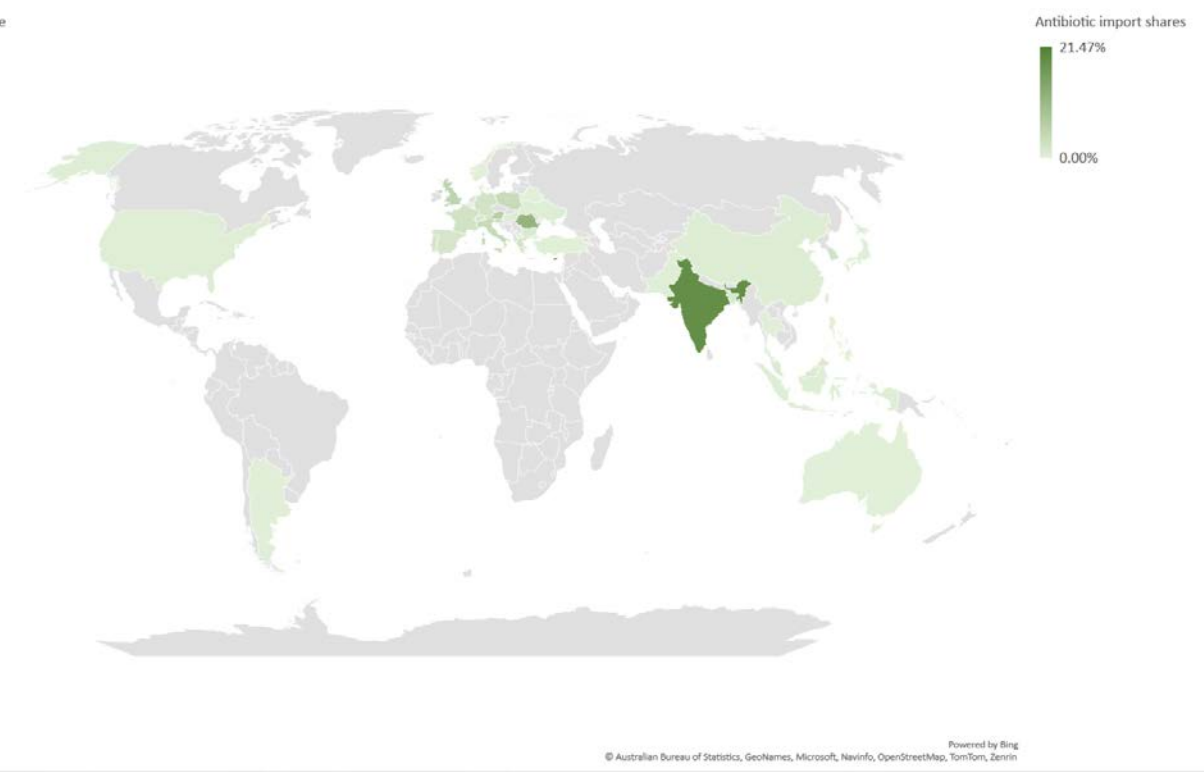
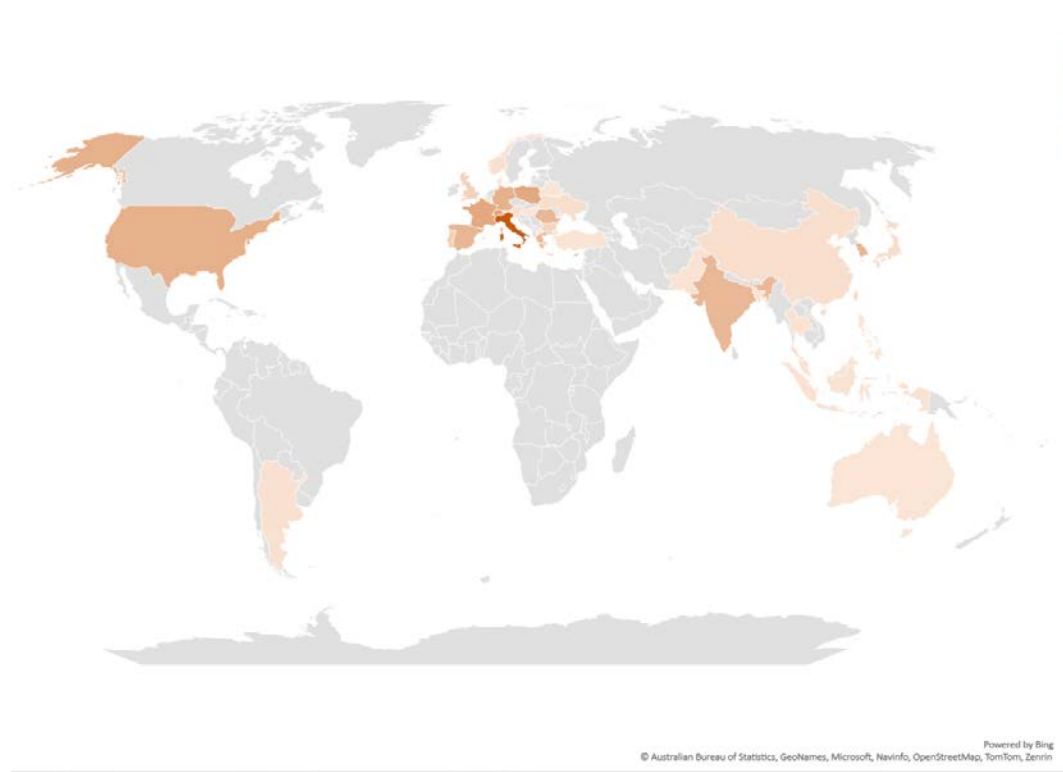


# Antibiotic use in critical care units



Dat, Vu Quoc et al., Antibiotic use for empirical therapy in the critical care units in primary and secondary hospitals in Vietnam: a multicenter cross-sectional study, *The Lancet Regional Health – Western Pacific*, Volume 18, 100306

Antibiotic resistance in Vietnam

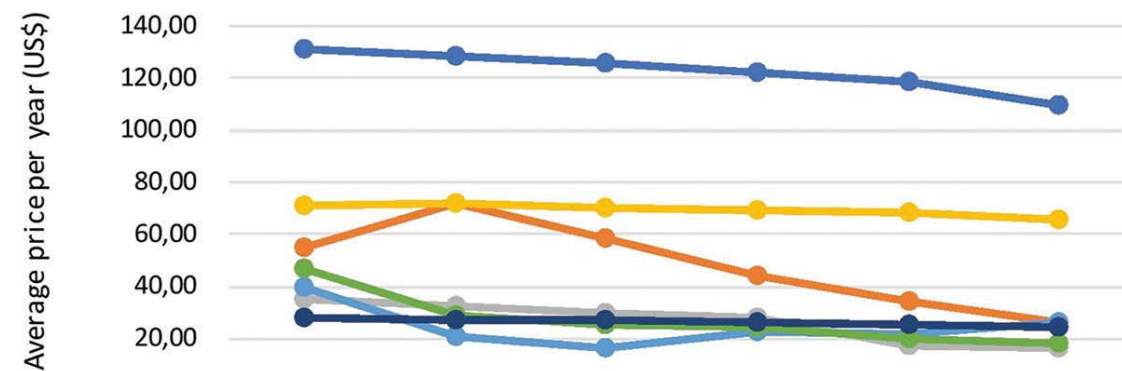


Unpublished data

# Last resource antibiotics

- Carbapenem price decrease by ~6.3% per year

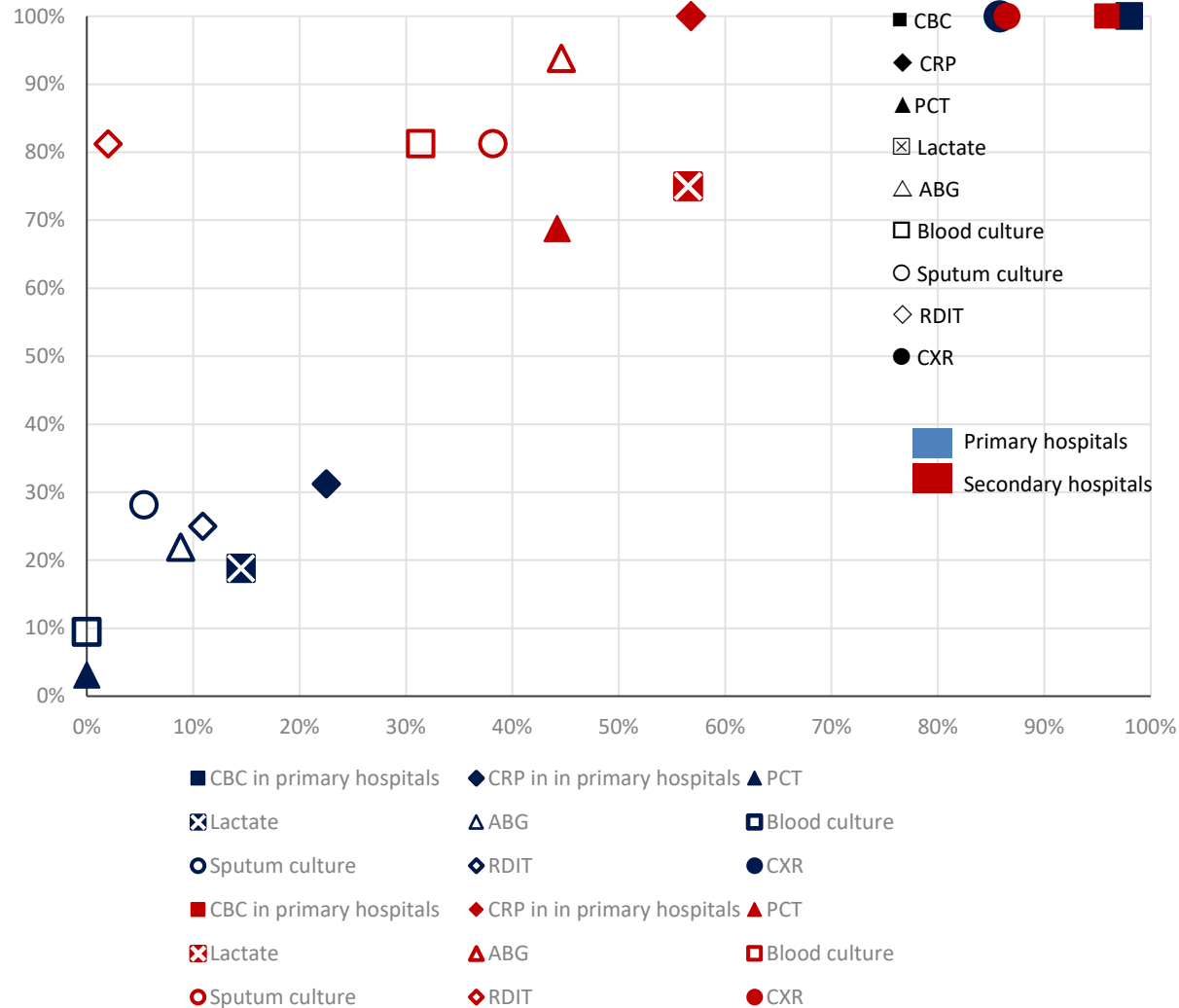
- 8.3% for meropenem
- 5.0% for imipenem/cilastatin
- 1.9% for ertapenem
- 4.1% for doripenem



Year	2013	2014	2015	2016	2017	2018
Meropenem (brand-name, Italy)	131,29	128,68	126,11	122,01	118,37	109,34
Meropenem (generic, Cyprus)	55,10	72,34	58,36	44,60	34,61	26,49
Imipenem (generic, North Korea)	35,47	32,47	30,21	27,60	17,52	16,12
Imipenem (brand-name, the US)	71,31	71,80	70,29	69,53	68,39	66,05
Imipenem (generic, Vietnam)	39,79	20,71	16,20	22,85	21,85	25,92
Imipenem (generic, India)	47,29	29,04	25,66	24,14	20,08	17,81
Ertapenem (brand-name, France)	27,66	26,90	27,11	26,41	25,51	24,64

\* The data included only drugs that were available in the market for 6 consecutive years.

- Other Reserve antibiotics are limited and high cost



# Laboratory capacity

Observational study among 1759 patients in 32 primary and 16 secondary hospitals in 5 provinces in 2019

Microbiological culture are available in 80% secondary hospitals and 30% primary hospitals, only 4.5% and 37% patients with SARI in corresponding hospitals can access

# National plans on antimicrobial resistance (2013-2020)

- Raise awareness of the community and health workers about drug resistance
- Strengthening the national surveillance system on antibiotic use and resistance
- Ensure adequate supply of quality drugs to meet health care needs
- Strengthening the safe and rational use of drugs
- Strengthening infection control
- Strengthen the rational and safe use of antibiotics in farming and raising livestock, poultry and aquatic products
- The national plan for the period of 2022-2030 is under reviewed





# THANK YOU

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