Multi-centre Study to Establish MIC and Zone Diameter Epidemiological Cut-off (ECOFF) Values for <i>Burkholderia pseudomallei</i>


1 EUCAST Development Laboratory, Växjö, Sweden; 2 Lao-Oxford-Mahosot Hospital-Wellcome Trust Research Unit, Vientiane, Laos; 3 Cambodia Oxford Medical Research Unit, Siem Reap, Cambodia; 4 Mahidol-Oxford Tropical Medicine Research Unit, Faculty of Tropical Medicine, Mahidol University, Bangkok, Thailand; 5 Royal Darwin Hospital, Darwin, Australia; 6 Townsville Hospital, Townsville, Australia; 7 Bundeswehr Institute of Microbiology, Munich, Germany; 8 Public Health Agency of Sweden, Stockholm, Sweden; 9 Robert Koch Institute, Berlin, Germany

L 0027

Introduction

<i>Burkholderia pseudomallei</i> is the causative agent of melioidosis, a life-threatening infection that occurs predominantly in Southeast Asia and northern Australia. It is a laboratory Risk Group 3 organism in most countries and a potential bioterror agent ('Tier 1 Select Agent'). Although melioidosis requires intensive antimicrobial treatment, standardised antimicrobial susceptibility testing (AST) guidelines are currently lacking.

Objectives

In this study, we aimed to produce MIC and zone diameter distributions on which to set epidemiological cut-off (ECOFF) values for <i>B. pseudomallei</i> using EUCAST methodology for non-fastidious organisms.

Methods

Non-consecutive clinical isolates of <i>B. pseudomallei</i> (including isolates with resistance to relevant agents from previous testing) were selected at eight study centres (16-70 per centre) and tested against antimicrobials listed in Table 1 by the EUCAST disk diffusion method and broth microdilution (BMD) according to ISO 20991-1, between November 2018 and January 2019. Quality control (QC) of the antimicrobial disks (Oxoid, Basingstoke, UK) and BMD panels (Merlin Diagnostika, Bornheim-Hersel, Germany) was performed at the EUCAST Development Laboratory (EDL) before they were shipped to the participating centres where QC was repeated before testing of clinical isolates. Guidance on performance of the tests and interpretation of results was provided by EDL. Each centre tested clinical isolates together with four QC strains (<i>Escherichia coli</i> ATCC 25922, <i>E. coli</i> ATCC 35218, <i>Pseudomonas aeruginosa</i> ATCC 27853 and <i>Staphylococcus aureus</i> ATCC 29213). Aggregated results were analysed according to EUCAST SOP 10.0 'MIC distributions and the setting of ECOFF values' and MIC and zone diameter ECOFFs were determined by ECOFFinder program (available at www.eucast.org/mic_distributions_and_ecoff) and visual estimation.

Results

Disk diffusion and MIC results for 373 <i>B. pseudomallei</i> were collected from eight centres. MIC-zone diameter correlations are presented in Figure 1 and the proposed ECOFFs are listed in Table 1.

Conclusions

In this multi-centre study, we have validated the use of standard MIC and disk diffusion methodology for AST of <i>B. pseudomallei</i> and determined MIC and zone diameter ECOFFs for <i>B. pseudomallei</i> against eight antimicrobials. The ECOFFs can distinguish between wild-type (WT) and non-WT isolates and can serve as background data when determining clinical MIC breakpoints and corresponding zone diameter breakpoints.

Acknowledgements: We would like to gratefully acknowledge the assistance of Pisey Tan, Cathy Engler, Christina Hinzi, Anke Stark, Silke Becker, Petra Lochau for their valuable contributions to the study. We also acknowledge the helpfulness of Holger Scheldetzkj and Martin Diagnostika.

For more information, please contact onur.karatuna@kronoberg.se
Evaluation of gradient tests for vancomycin MIC determination in Enterococcus faecalis and Enterococcus faecium.

Effect of incubation for 16-20 hours vs. 24 hours.

P 1754

Amra Basic1, Erika Matuschek1, Onur Karatuna1, Bjørg Haldorsen2, Kristin Hegstad2, Jenny Åhman1, Arnfinn Sundsfjord3 and Gunnar Kahlmeter1

1EUCAST Development Laboratory, Växjö, Sweden, 2Norwegian National Advisory Unit on Detection of Antimicrobial Resistance, Department of Microbiology and Infection Control, University Hospital of North Norway, Tromsø, Norway.

Introduction

According to the broth microdilution (BMD) ISO standard (20776-1), as well as the manufacturers’ instructions for gradient tests, vancomycin MICs shall be read after 24h incubation. In reality, results are often read after 16-20h incubation, which is the standard recommendation for most antimicrobial agents.

Objective

The objective of this study was to evaluate vancomycin gradient tests from three manufacturers in a collection of enterococci with several low-level resistant isolates using BMD (24h) as reference.

Methods

Vancomycin MIC determination was performed on 40 E. faecium (23 vanB positive) and 15 E. faecalis (2 vanB positive) with reference MICs ranging from ≤0.5 to >16 mg/L. The isolates were collected from Norwegian hospitals during 2012-2018. Gradient tests from three manufacturers: Etest (bioMérieux), MIC Test Strip (MTS, Liofilchem) and M.I.C.Evaluator (MICE, Thermo Fisher Scientific) were tested on BBL Mueller-Hinton agar.

BMD was performed on custom sensititre panels. All tests were read after 16-20h and 24h incubation. BMD MICs read after 24h incubation (ISO 20776-1) were used as reference. E. faecalis ATCC 29212 was used as quality control. Essential and categorical agreements were calculated according to ISO 20776-2 vs. EUCAST Breakpoint Tables v8.1.

Results

All vanB-negative isolates were categorised susceptible with reference BMD (24h), but four isolates were categorised susceptible despite the presence of vanB genes. These isolates had reference MICs of 2-4 mg/L.

Essential and categorical agreements vs. BMD (24h) are presented in Table 1. BMD with 16-20h incubation resulted in four very major errors (VME), all with MICs close to the breakpoint. The three gradient tests underestimated vancomycin MICs for resistant isolates, resulting in high numbers of VME. For MICE, incubation for 24h improved the results (5 vs. 15 VME), but there was no or little improvement between 16-20h and 24h for Etest and MTS.

See figure 1 for correlation between reference and test MICs.

Figure 1. Correlation for vancomycin MIC values between three different gradient test manufacturers (Etest, MTS and MICE) and reference broth microdilution read at 24h. Results for the gradient tests are shown for BBL Mueller-Hinton (MMH) agar. MICs identical with reference MICs are highlighted in dark blue. EUCAST breakpoints (SS4, R=4 mg/L) are shown as lines. Red text = categorical error

Conclusions

None of the phenotypic MIC tests could detect all vanB-positive strains. BMD over 24h performed better than BMD over 16–20h. Gradient tests underestimated vancomycin MICs at both 16-20h and 24h incubation (in accordance with the manufacturers’ instructions). The poorest results were observed with the shorter incubation time.

EUCAST has published a warning against the use of gradient test for vancomycin MIC determination for enterococci and this study shows the importance of following the recommendation to incubate for 24h.

Table 1. Essential and categorical agreement of vancomycin MIC methods using BMD (24h) as reference for clinical isolates of enterococci.

<table>
<thead>
<tr>
<th>MIC (mg/L)</th>
<th>Etest</th>
<th>MTS</th>
<th>MICE</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤0.5</td>
<td>1</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>4</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>8</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>16</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>&gt;16</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>

Note: MICs as BMD (24h)

1 Number of isolates with actual MICs (truncated MICs either ≤ or >) excluded
2 Number of MICs within ± 1 dilution of reference MICs
3 Number of MICs within categorical agreement
4 Number of MICs susceptible with reference method, resistant with test method (false resistant)
5 Number of MICs resistant with reference method, susceptible with test method (false susceptible)

For more information, please contact amra.basic@kronoberg.se
EUCAST evaluation of 21 Mueller Hinton plates for disk diffusion testing - wide differences detected

Jenny Åhman¹, Erika Matuschek¹, Anna-Karin Wallgren² and Gunnar Kahlmeter¹

¹EUCAST Development Laboratory, Växjö, Sweden ²Clinical Microbiology, Blekingesjukhuset, Karlskrona, Sweden

Introduction
The accuracy of susceptibility testing is dependent on the quality of the materials used. We have previously shown wide variation in antimicrobial disks from nine manufacturers (Åhman et al, CMI 2019:25(3):346-352). Mueller-Hinton (MH) media is recommended for disk diffusion susceptibility testing by both CLSI and EUCAST, and has been used worldwide for several decades. MH agar can be produced in-house from dehydrated powder or bought as pre-poured agar plates.

Objective
The objective of this study was to evaluate the performance of 21 dehydrated MH agar powders using EUCAST methodology and quality control (QC) criteria.

Methods
MH agar plates were prepared in-house from 21 dehydrated powders from 17 manufacturers (Table 1) according to each manufacturers instructions. Disk diffusion testing following EUCAST methodology was performed for four QC strains; Escherichia coli ATCC 25922, Pseudomonas aeruginosa ATCC 27853, Staphylococcus aureus ATCC 29213 and Enterococcus faecalis ATCC 29212. Testing was performed with antimicrobial disks, representing different antimicrobial classes, from a manufacturer with good quality in our previous study (Oxoid, Thermo Fisher Scientific). Each QC strain was tested in triplicate using three separate inoculum suspensions. Each suspension was applied to the 21 different MH agars in parallel. The agar plates were tested blindly and zone diameters read by a single technician. Results were evaluated against criteria in EUCAST Quality Control Tables v. 9.0 (identical to those of CLSI for 33% of the evaluated combinations). The agar depth and the pH (using a surface electrode) were measured for each product.

Table 1. Performance of 21 different brands of Mueller Hinton (MH) powders for disk diffusion testing

<table>
<thead>
<tr>
<th>Total rating*</th>
<th>Manufacturer</th>
<th>Product name</th>
<th>Product code</th>
<th>Percent zones on QC target ±1 mm</th>
<th>Percent zones outside QC range</th>
<th>Agents outside range, high</th>
<th>Agents outside range, low</th>
<th>pH</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>BioRad</td>
<td>MH Agar</td>
<td>K8704</td>
<td>66</td>
<td>0</td>
<td>7.28</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Biokar</td>
<td>MH Agar</td>
<td>K71402</td>
<td>61</td>
<td>1.1 TS</td>
<td>7.29</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Oxoid</td>
<td>MH Agar</td>
<td>SM0307</td>
<td>78</td>
<td>1 TS</td>
<td>7.25</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Sigma</td>
<td>MH Agar</td>
<td>K7580</td>
<td>61</td>
<td>0</td>
<td>7.25</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Becton DIC</td>
<td>BBL Bile Agar</td>
<td>K13104</td>
<td>79</td>
<td>0</td>
<td>7.25</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Heka Diagnostics</td>
<td>Heka Agar</td>
<td>CE421</td>
<td>71</td>
<td>0</td>
<td>7.31</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Becton DIC</td>
<td>MH Agar</td>
<td>K750500</td>
<td>64</td>
<td>0</td>
<td>7.26</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>Alfa Biocare</td>
<td>MH Agar</td>
<td>K11102</td>
<td>71</td>
<td>0.3 CS</td>
<td>7.23</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>Becton DIC</td>
<td>BBL Bile Agar</td>
<td>K13205</td>
<td>73</td>
<td>0.3 CA, AM, TS</td>
<td>7.33</td>
<td></td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>Sigma</td>
<td>MH Agar</td>
<td>10191</td>
<td>57</td>
<td>0.3 CS</td>
<td>7.27</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>Himedia</td>
<td>MH Agar</td>
<td>K1731</td>
<td>57</td>
<td>0</td>
<td>7.30</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>BioMerieux</td>
<td>BBE Agar</td>
<td>11026</td>
<td>55</td>
<td>0.3 TS</td>
<td>7.33</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>Acumedia</td>
<td>MH Agar</td>
<td>7101</td>
<td>55</td>
<td>0.3 AM</td>
<td>7.35</td>
<td></td>
<td></td>
</tr>
<tr>
<td>21</td>
<td>Romer</td>
<td>MH Agar</td>
<td>RM0050</td>
<td>52</td>
<td>0.7 AM</td>
<td>7.26</td>
<td></td>
<td></td>
</tr>
<tr>
<td>23</td>
<td>Lab M</td>
<td>MH Agar</td>
<td>LA0039</td>
<td>69</td>
<td>0.7 AM, TS</td>
<td>7.29</td>
<td></td>
<td></td>
</tr>
<tr>
<td>23</td>
<td>Merck</td>
<td>MH Agar (CLSI)</td>
<td>VM0430</td>
<td>68</td>
<td>0.7 AM, TS</td>
<td>7.29</td>
<td></td>
<td></td>
</tr>
<tr>
<td>27</td>
<td>Maxi Group</td>
<td>MH Agar</td>
<td>SM110</td>
<td>59</td>
<td>0.9 CA, FQ</td>
<td>7.35</td>
<td></td>
<td></td>
</tr>
<tr>
<td>27</td>
<td>Slin</td>
<td>MH Agar</td>
<td>TN1104</td>
<td>60</td>
<td>0.7 AM, TS</td>
<td>7.25</td>
<td></td>
<td></td>
</tr>
<tr>
<td>27</td>
<td>Himedia</td>
<td>MH Agar No 2</td>
<td>SM07064</td>
<td>57</td>
<td>0.9 LA, AM, TS</td>
<td>7.28</td>
<td></td>
<td></td>
</tr>
<tr>
<td>40</td>
<td>BioLabs</td>
<td>Blod Agar</td>
<td>K11070500</td>
<td>52</td>
<td>0.10 PC, MA, TE</td>
<td>7.22</td>
<td></td>
<td></td>
</tr>
<tr>
<td>44</td>
<td>Merck</td>
<td>MH Agar</td>
<td>100037</td>
<td>61</td>
<td>0.3 CS, LA, FQ, AM, TE</td>
<td>7.34</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* This list can under normal circumstances be obtained only as pre-poured agar plates.

Mean values (30 per agar) from triplicate tests of each QC strain and agent were rated 0, -1, -3 or -5 depending on how the mean value related to the QC criteria (Table 1). The accumulated rating for each agar was -4 to -55. The best results were seen with MH agar from Bio-Rad, Biotop, Oxoid, Sigma (MH 2), Becton Dickinson (BBL MH II) and Hardy Diagnostics, for which ≥99% of the readings were within QC ranges and ≤70% within target ±1 mm. The poorest results were obtained with MH agar from Biolab and Merck (MH agar) with 10% and 23% of readings outside the QC ranges, respectively.

Of the total number of readings in the study (n=1890), 4.9% were outside the QC ranges, mostly related to trimethoprim-sulfamethoxazole (25/189), aminoglycosides (25/315) and fluoroquinolones (15/252). These problems may be related to different concentrations of cations and thymine in the agar.

The agar depth was within acceptable limits (4 ±0.5 mm) for all products and pH within acceptable limits (7.2-7.4) for all but four agars (2 high and 2 low, Table 1).

Conclusions
There were significant differences between the 21 Mueller-Hinton agars. Some agars showed excellent results and fully met QC criteria recommended by EUCAST and CLSI. Some agars failed on specific antimicrobial agents and a few showed overall unacceptable performance. This may lead to incorrect susceptibility categorisation of clinical isolates.

Laboratories must ascertain that the MH agar used performs in accordance with EUCAST recommendations. If QC criteria are not met, and disk quality is ruled out as the cause, laboratories should investigate if discrepancies are related to the MH brand.

For more information, please contact jenny.ahman@escmid.org
Development of a EUCAST disk diffusion method for *Nocardia* spp.

Per Rydström¹, Erika Matuschek², Jenny Åhman² and Gunnar Kahlmeter²

¹Department of Clinical Microbiology, Central Hospital, Växjö, Sweden; ²EUCAST Development Laboratory, Växjö, Sweden

**Introduction**

*Nocardia* species are environmental bacteria causing a variety of infections, especially in immunocompromised patients. CLSI recommends using broth microdilution (BMD) for antimicrobial susceptibility testing (AST) in accordance with their protocol for aerobic actinomycetes (M24-A2). EUCAST has not yet published any recommendation for AST of *Nocardia* spp.

**Objective**

The aim of this study was to develop a disk diffusion method for *Nocardia* spp. that deviate as little as possible from the EUCAST standard disk diffusion methodology for fastidious organisms.

**Methods**

AST was performed on *Nocardia* isolates of varying species. BMD was performed with un-supplemented Mueller-Hinton (MH) broth (as per CLSI M24-A2) and with the EUCAST broth for fastidious organisms, MH-F broth, on RAPMYCOI Sensititre plates (Thermo Fisher Scientific). For disk diffusion, the following parameters were varied: medium (MH and MH-F agar), media manufacturer (BBi/BD, Bio-Rad and Oxoid/Thermo Fisher Scientific), inoculum preparation (glass beads and cotton swab), the effect of varying the age of the inoculum, inoculum density (McF 0.5 and 1.0), incubation environment (air and 5% CO₂) and incubation time (24, 48 and 72 h).

BMD (sealed panels) and disk diffusion plates were incubated at 35°C. The inoculum preparation using glass beads described in M24-A2 is labor intensive and time consuming and it was therefore specifically investigated if a rolling cotton swab technique could replace this part of the inoculum preparation.

Figure 1a, b and c. Inhibition zone distributions for *Nocardia* spp. and amikacin 30 µg using the proposed method (McF 0.5 and MH-F agar in CO₂) after 24, 48 and 72 hours incubation.

**Results**

Growth with BMD was poor, both with MH and MH-F broth. Preparing the inoculum using a cotton swab produced a more homogeneous suspension and improved growth significantly compared to using glass beads. With the cotton swab technique for disk diffusion, the standard McF 0.5 inoculum produced confluent growth after 24 h incubation for 50% (MH agar in air) and 71% (MH-F agar in CO₂) of the isolates respectively. In general, MH-F agar incubated in CO₂ was preferred over MH agar in air due to the slightly improved growth and readability of zone diameters.

Increasing the inoculum to McF 1.0 did not improve growth. With an increase of the incubation time from 24 to 48 h an improvement was registered (confluent growth for 86% for both MH and MH-F agar). Only a slight improvement was seen with an increase to 72 h. Some variability in inhibition zone size was observed between different agar manufacturers for trimethoprim-sulfamethoxazole. Inhibition zones on MH-F agar with a McF 0.5 inoculum are presented in Figures 1 and 2.

**Conclusions**

Our study indicates that the EUCAST disk diffusion method for fastidious organism can be used for *Nocardia* spp. when using a rolling cotton swab technique to prepare the inoculum. We will evaluate reproducibility further. Neither standard MH broth, nor EUCAST MH-F broth, produced satisfactory growth for BMD. Most likely agar dilution should be preferred as a reference method for *Nocardia*.

Acknowledgements for contribution with isolates: Jeffrey Fuller and Tanis Dingle, Provincial Laboratory for Public Health, Edmonton, AB, Canada; Christian Giske, Karolinska University Hospital, Stockholm, Sweden

For more information, please contact per.rydstrom@kronoberg.se
EUCAST antimicrobial susceptibility testing: *Haemophilus influenzae* and beta-lactam agents

**Erika Matuschek**, Jenny Åhman, Stina Bengtsson, Paul R. Rhomberg, Ronald N. Jones and Gunnar Kahlmeter

1 EUCAST Development Laboratory, Växjö, Sweden; 2 JMI Laboratories, North Liberty, Iowa, USA

**Introduction**

Beta-lactam resistance in *Haemophilus influenzae* is caused by beta-lactamase production and/or mutations in the penicillin-binding proteins (PBPs). Due to increasing resistance related to PBP3 mutations, antimicrobial susceptibility testing (AST) of *H. influenzae* against beta-lactam agents is subject to several difficulties. These are partly related to that isolates with PBP3 mutations may be categorised as either susceptible or resistant when applying EUCAST clinical MIC breakpoints.

**Objectives**

The aim of this study was to review and improve EUCAST recommendations for disk diffusion testing of *H. influenzae* against beta-lactam agents.

**Methods**

AST was performed for all beta-lactam agents with EUCAST breakpoints, including the benzylpenicillin (PCG) 1 unit screening disk, on a collection of *H. influenzae* (n=138) intentionally biased towards beta-lactam resistance. The isolates were from the worldwide SENTRY collection (JMI Laboratories, USA). All isolates were examined for beta-lactamase production with a nitrocefin disk and investigated for PBP3 mutations with PCR. Broth microdilution (BMD) was performed according to ISO 20776-1 on custom Sensititre panels (Thermo Fisher Scientific) using EUCAST broth for fastidious organisms (MH-F broth). Disk diffusion was performed according to EUCAST methodology for fastidious organisms (MH-F media) using agar from BD (BBL) and Thermo Fisher Scientific (Oxoid). MIC-zone diameter correlations were evaluated vs. EUCAST Breakpoint Tables v 8.1, 2018.

**Results**

The following beta-lactam resistance mechanisms were identified among the tested isolates: beta-lactamase only (n=23), PBP3 mutations only (n=55) and both beta-lactamase and PBP3 mutations (n=9). Fifty-one isolates had no beta-lactamase resistance mechanisms.

The PCG screening disk correctly identified 86 of 87 isolates with beta-lactamase as screen positive (PCG ≥12 mm), Figure 1a. Screen-negative isolates (PCG ≥12 mm) were susceptible for all beta-lactam agents with EUCAST breakpoints, with the exception of cefotaxime which had two minor errors. Results for the PCG screening disk for clinical consecutive isolates from Kronoberg and Blekinge county, Sweden, are shown in Figure 1b.

The correlation between MICs and zone diameters for each agent was excellent for isolates without beta-lactamase resistance and those with beta-lactamase only (see examples for ampicillin in Figure 2). For isolates with PBP3 mutations, there was significant overlap between susceptibility categories with disk diffusion, in particular for ampicillin, amoxicillin-clavulanic acid, cefepime, cepodoxime, cefuroxime and imipenem.

**Conclusions**

EUCAST recommends screening for beta-lactam resistance in *H. influenzae* with the benzylpenicillin 1 unit disk. Screen-negative isolates have no beta-lactamase resistance and can be reported susceptible for all beta-lactam agents with clinical breakpoints.

For screen-positive isolates and some agents, there is poor separation between susceptible and resistant isolates. For those combinations, EUCAST has introduced Areas of Technical Uncertainty (ATUs), included in the EUCAST Breakpoint Tables v 9.0, 2019. This results in more reliable AST reports for *H. influenzae* against beta-lactam agents.

For more information, please contact: erika.matuschek@kronoberg.se

---

**Figure 1.** Inhibition zone diameter distributions for *H. influenzae* and benzylpenicillin 1 unit

a) vs. beta-lactam resistance mechanism (n=138) and b) for consecutive clinical isolates (n=836).

EUCAST screening breakpoint for benzylpenicillin 1 unit is shown as a dotted line.

---

**Figure 2.** Inhibition zone diameter distributions for *H. influenzae* and ampicillin 2 μg vs. ampicillin MIC (≤1 mg/L) presented per beta-lactam resistance mechanism.

EUCAST clinical breakpoints are shown as dotted lines.