



Artificial intelligence-assisted antimicrobial susceptibility testing (AST)

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- **Background**

- Methods

- Results

- Conclusions

Background – conventional AST / disk diffusion


- Conventional AST still state of the art
- MIC remains gold-standard
- Disk-diffusion valid alternative
 - EUCAST breakpoints
 - Better standardization
 - Automation increasingly possible
 - Plate inoculation
 - Reading

Background – APAS Independence

- Automated Plate Assessment System (APAS®)
 - Stand-alone culture plate reader
 - Artificial Intelligence (AI) for interpretation of pictures
 - Applications for
 - Urine
 - Growth / no growth (FDA)
 - Cfu / organism differentiation
 - MRSA
 - Growth / no growth / specific growth
 - VRE
 - Growth / no growth / specific growth

Background – APAS Independence

- APAS[®]-AMR-Application
 - Automated reading of disk diffusion plates
 - Image based antibiotic disc recognition system
 - EUCAST and CLSI supported discs
 - Multiple manufacturers
 - No pre-entry of disc logic required
 - Detection of D-zones and Disc synergies (Key holes)
 - Lawn quality checks
 - Support measurement and S/I/R interpretation

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Methods – Study design

- Proof-of-concept study comparing
 - Pre-release software of the APAS[®]-AMR-Application
 - Automated reading of disk diffusion plates
 - Image based antibiotic disc recognition
 - Automated measuring of zone-diameters
 - 110 clinical isolates
 - AST read at 6h and 24h by APAS and humans
 - Interpretation using EUCAST breakpoints

Methods – Antimicrobials and Organisms

- Antimicrobials
 - Gram negative panel: Ceftazidime, Ceftazidime-Avibactam, Ceftolozane-Tazobactam, Imipenem, Meropenem, Ciprofloxacin
 - Gram positive panel: Ampicillin, Cefotaxime, Gentamicin, Clindamycin, Imipenem, Vancomycin

- Organisms
 - *S. aureus*
 - *E. coli*
 - *K. pneumoniae*
 - *P. aeruginosa*
 - *E. faecalis*

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Results – Measurements

▼ Report

Mueller-Hinton: Successful Measurement

Growth
C-T: 28.6 mm
CAZ10: 25 mm
CIP5: 29.7 mm
CZA14: 27.2 mm
IMI10: 30.4 mm
MEM10: 32.2 mm
Reason for Review
N/A
Count
-

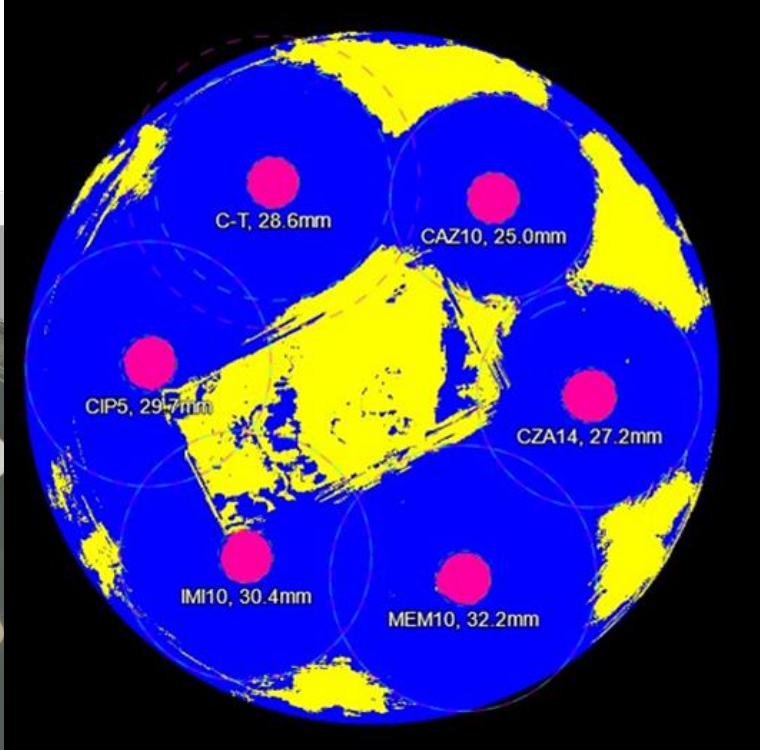
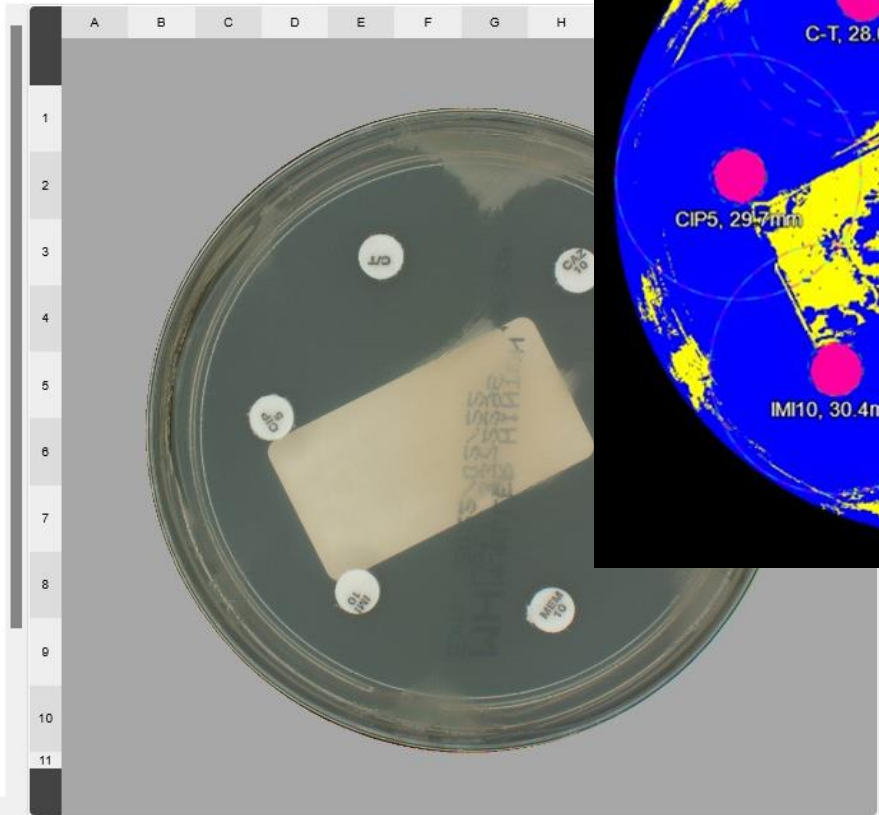
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-1
Capture Time
20-03-2022 16:54:53

▼ Image

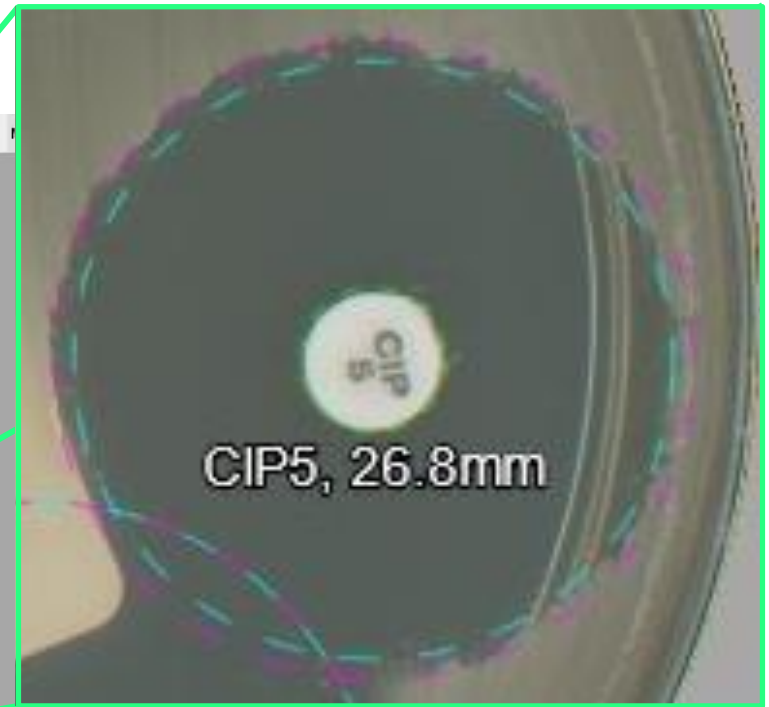
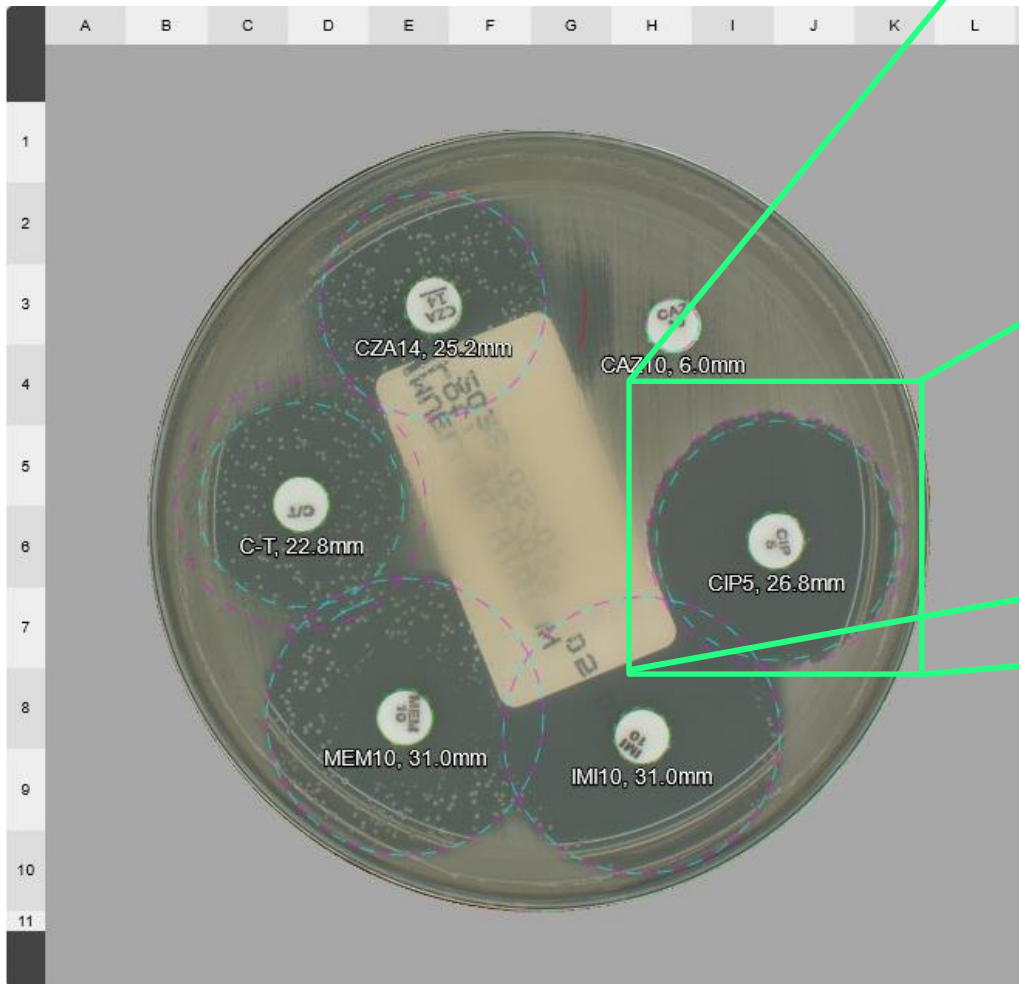
Top Lit Image

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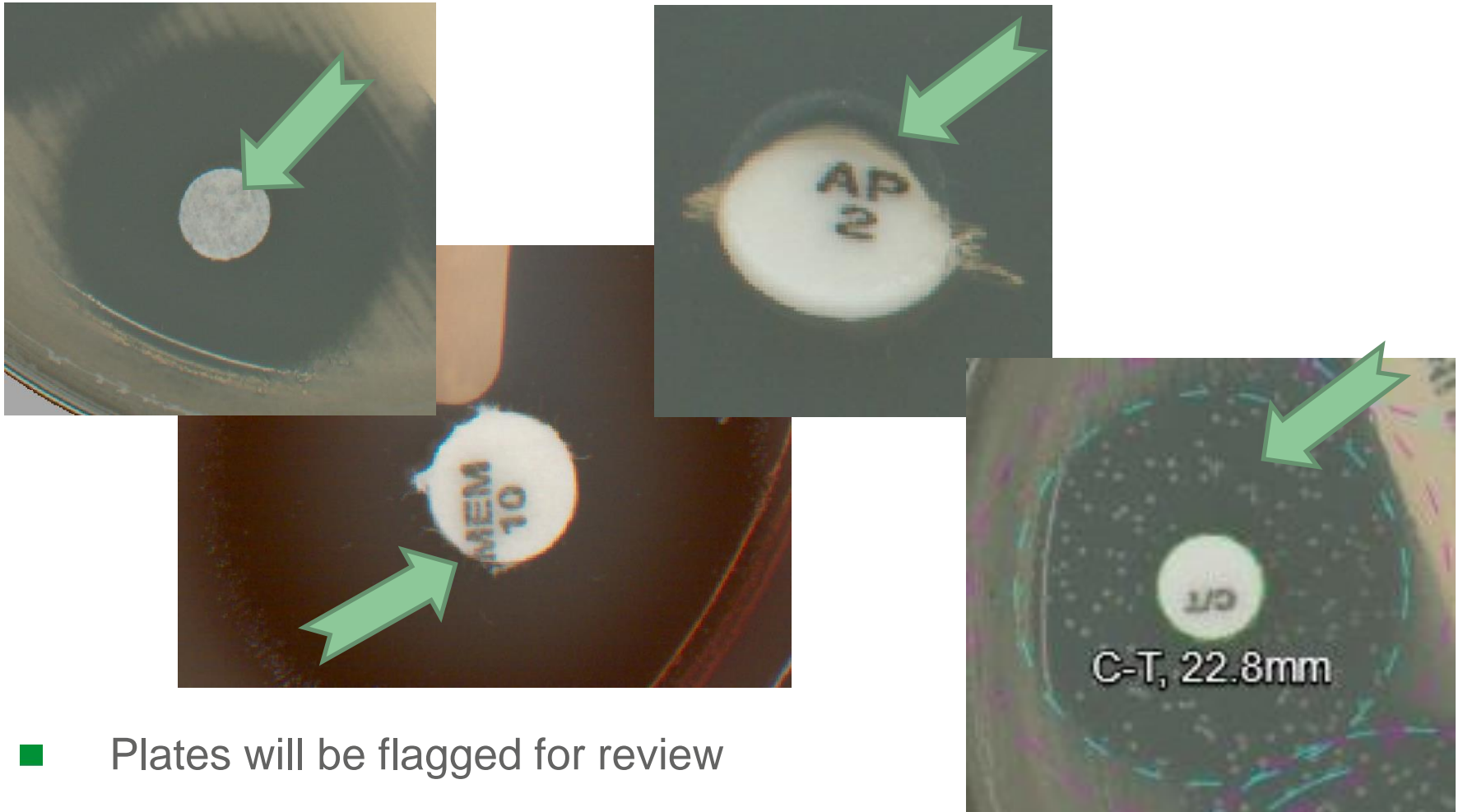
shift+drag to measure clear



Results – Zone identification



Results – Disk Errors / Mutant Detection



- Plates will be flagged for review

Results – Performance at 6 Hours (RAST-Breakpoints)

Organism	Disc reads	No error	Minor Error	Major Error	Very Major Error
<i>E. coli</i> (n=23)	132	97.0%	0%	0%	3.0%
<i>K. pneumoniae</i> (n=26)	155	98.7%	0%	0%	1.3%
<i>Ps. aeruginosa</i> (n=21)	19	100%	0.0%	0%	0%
<i>S. aureus</i> (n=10)	8	100%	0%	0%	0%
<u>Total</u>	<u>314</u>	<u>98.1%</u>	<u>0%</u>	<u>0%</u>	<u>1.9%</u>

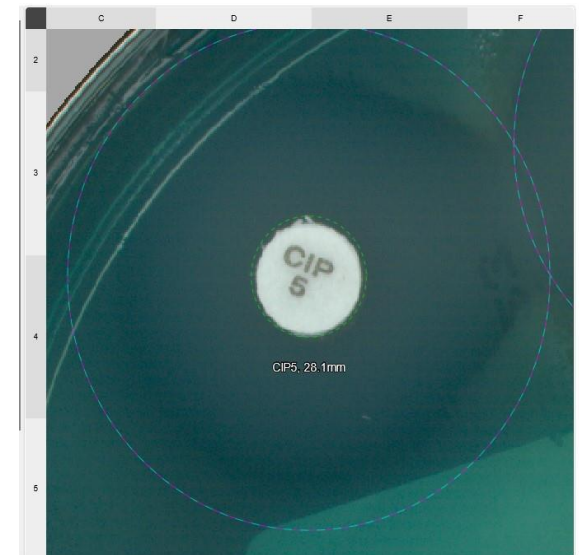
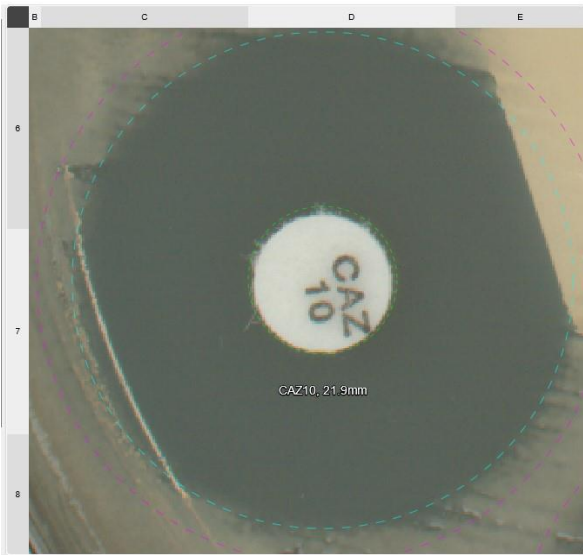
- Results without review-flags
- All plates with very major error (VME) were accurately flagged for review due to mutant detection

Results – Performance at 18-24 Hours

Organism	Disc reads	No error	Minor Error	Major Error	Very Major Error
<i>E. coli</i> (n=23)	138	100%	0%	0%	0%
<i>K. pneumoniae</i> (n=26)	155	96.2%	1.9%	0%	1.9%
<i>P. aeruginosa</i> (n=21)	125	90.4%	7.2%	0%	2.4%
<i>S. aureus</i> (n=10)	30	100%	0%	0%	0%
<i>E. faecalis</i> (n=30)	90	95.6%	3.3%	0%	1.1%
<u>Total</u>	<u>538</u>	<u>96%</u>	<u>2.6%</u>	<u>0%</u>	<u>1.3%</u>

- Results without review-flags
- Plates with "VME" were accurately flagged for review due to mutant detection (*K. pneumoniae*)

Results – Minor Errors



Human	21	I
APAS	21.9	S

Human	18	R
APAS	19	I


Human	21	I
APAS	21.9	S

- Variation in zone-measurements similar to human-human reads
- Minimal impact on SIR

Results – Zone Measurements

Organism	Average Delta (mm)	% 0-1 mm	%1-2mm	%2-3mm	%>3mm
<i>E. coli</i> (n=23)	1.5	62.3	21.0	5.8	10.8
<i>K. pneumoniae</i> (n=26)	1.5	61.3	22.6	9.0	7.1
<i>Ps. aeruginosa</i> (n=21)	2.2	41.6	25.6	11.2	21.6
<i>S. aureus</i> (n=10)	2.5	62.0	24.1	6.9	3.4
<u>Total</u>	1.9	56.8	23.3	8.2	11.6

- Over 88% agreement within 3mm
- Results without review-flags

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Conclusions

- In our study the AST reading / determination of zone-sizes and EUCAST-interpretation did show a high degree of correlation between APAS-AMR and human
- Low rates of errors in both RAST and standard EUCAST applications
- Additional QC features that will flag plates for review (zone edge confidence measurements, lawn quality etc) that can enhance AST-QC in clinical routine
- APAS-AMR has the potential to standardise disc diffusion testing with high throughput and accuracy and improve DD-QC

Acknowledgments

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Thank you