Improving Point-of-Care Testing Through Artificial Intelligence

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Disclosures

- Consulting and Advisory Board, Abbott Laboratories

Learning Objectives

After this presentation, participants should be able to:

- Describe how POCT can bridge the disparity gap posed by centralized hospital testing
- Discuss how AI can help in POC infectious disease testing
- Outline how AI can help with POC hematology testing

The Problem

Current World Population

7,937,795,433

view all people on 1 page >

TODAY	THIS YEAR
Births today	Births this year
105,922	**35,399,295**
Deaths today	Deaths this year
44,469	**14,861,472**
Population Growth today	Population Growth this year

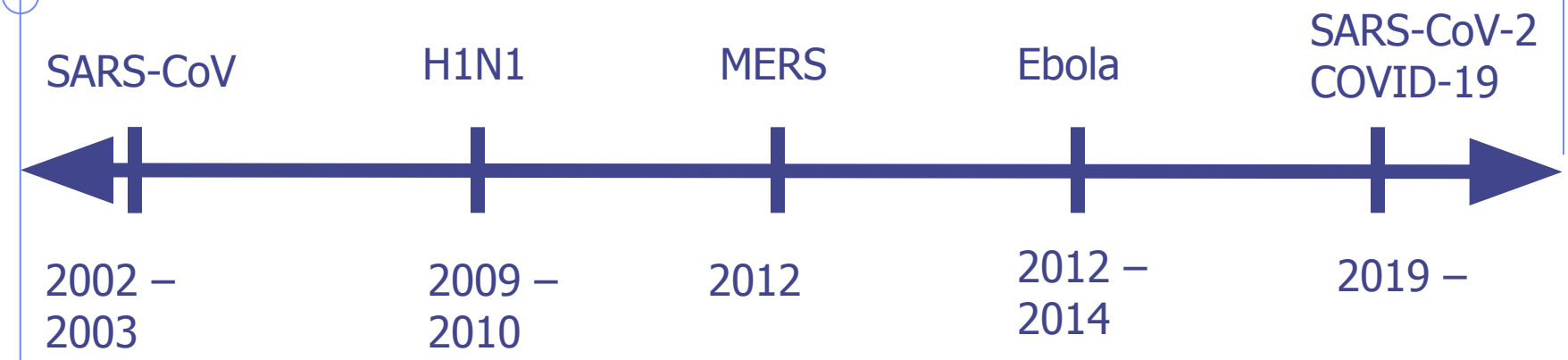

30


realme
oppo

Australian outback

Royal Darwin Hospital

Fool me once shame on you;
Fool me twice shame on me!



"Newdemics demand well-prepared critical care infrastructures ***if strong medical and economic penalties are to be avoided*** *. Point-of-care testing can contribute substantially…" (Kost 2006, POC 5(4):138-144*

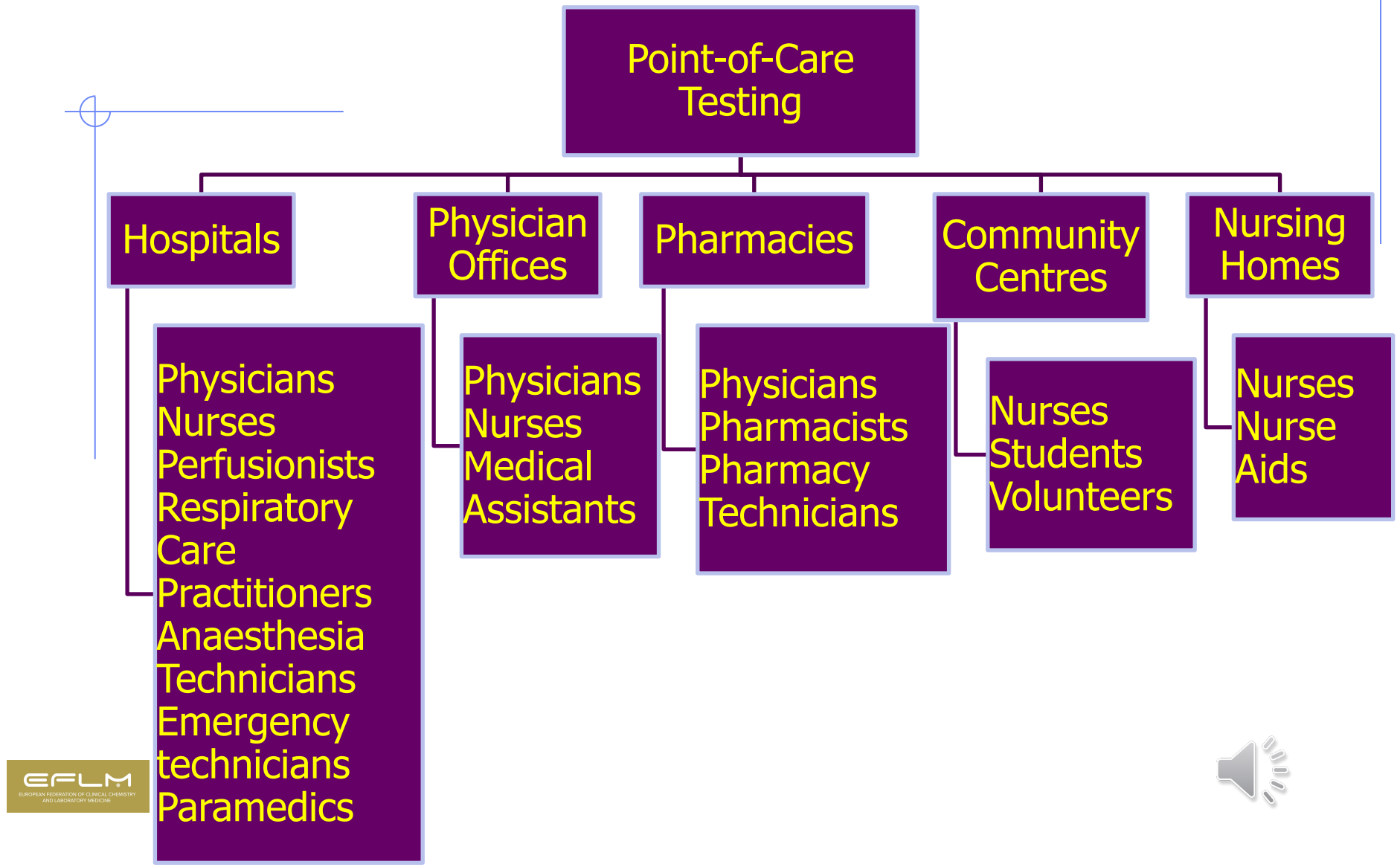
"Thus, the Ebola crisis is demonstrating the intrinsic value of POCT in assuring timely patient test results in ***infectious disease outbreaks*** *, which* ***should not be underestimated, because they wreak havoc on healthcare systems and entire economies*** *."*
Kost et al., , 2015, AJDM 10(1)1-23

The Solution?

Point-of-Care Testing -

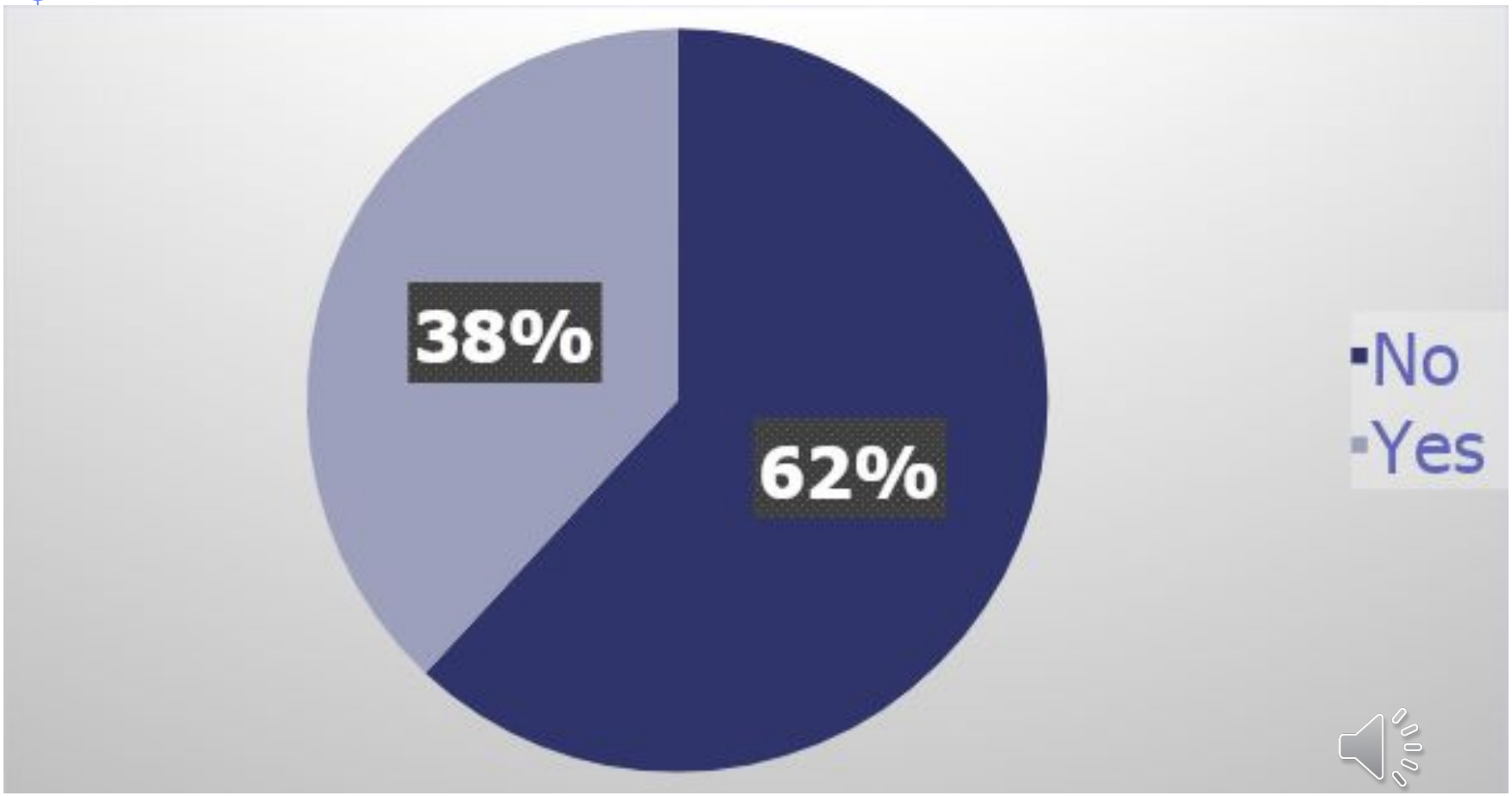
"Laboratory testing performed near the patient that generates a rapid result that enables timely clinical action for patient care."

- Testing of patient samples outside the confines of the clinical laboratory

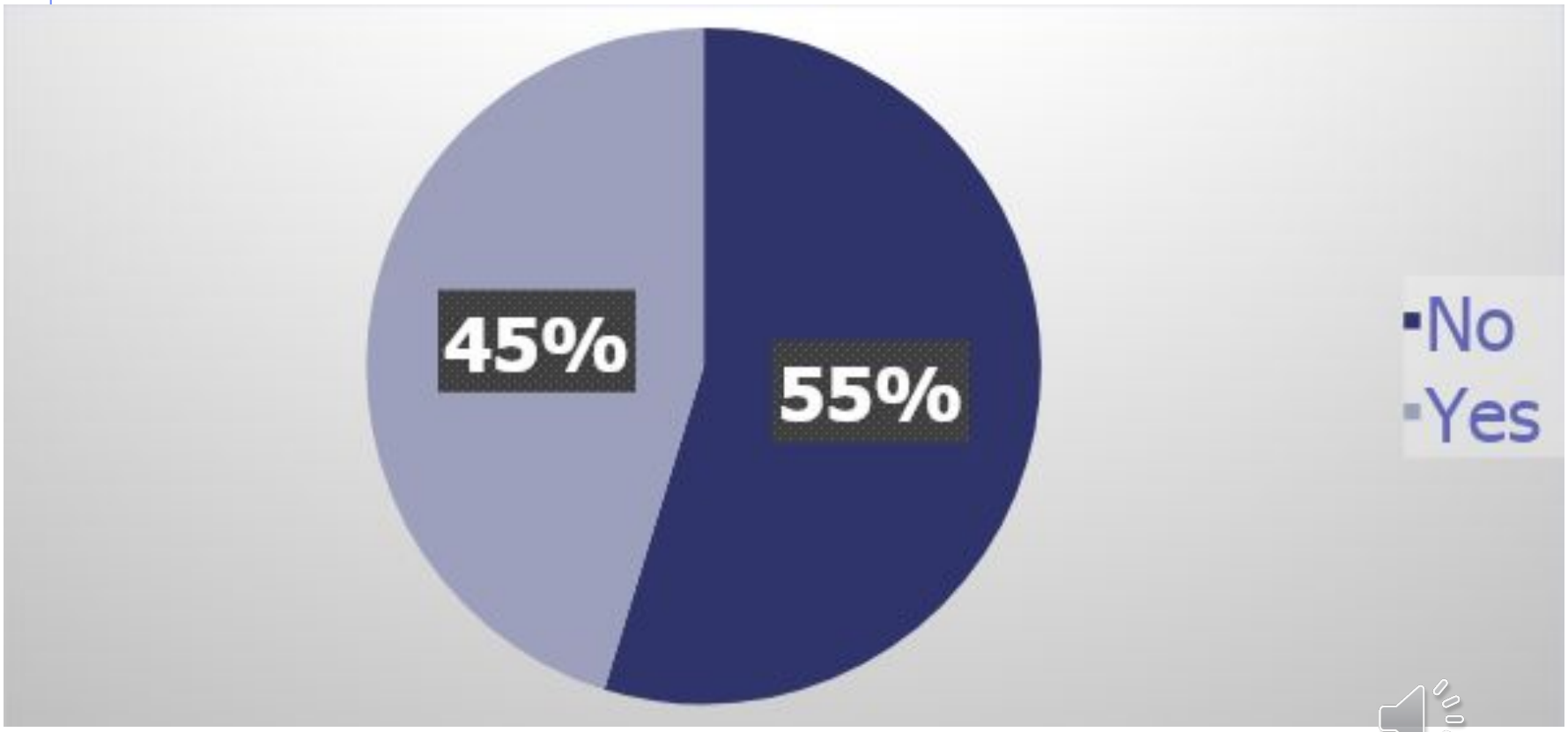

Point-of-Care Testing
Hospitals
Physician Offices
Pharmacies
Community Centres
Nursing Homes
Physicians
Nurses
Perfusionists
Respiratory Care Practitioners
Anaesthesia Technicians
Emergency technicians
Paramedics
Physicians
Nurses
Medical Assistants
Physicians
Pharmacists
Pharmacy Technicians
Nurses
Students
Volunteers
Nurses
Nurse Aids

Examples of Point-of-Care Devices

Does your Society have a Point-of-Care Testing Committee?



Is Point-of-Care Testing regulated in your country?



Challenges of POCT ?

- Training
- Competency (Quiz/Skills test)
- Quality Assurance
  - Controls
  - Troubleshooting
- These are **important** in getting a **reliable result**

Challenges in Training…

- Management of Training:
  - Number of staff requiring training be in the thousands
  - A high turnover rate
  - Nursing staff can be transferred between different departments
  - Poor communication between nursing administration and POC coordinator

Artificial Intelligence & test reliability

- AI can help in getting a reliable result
- AI - wide-ranging discipline and includes:
  - Machine learning
  - Robotics
  - Visual computation.

AI and ML

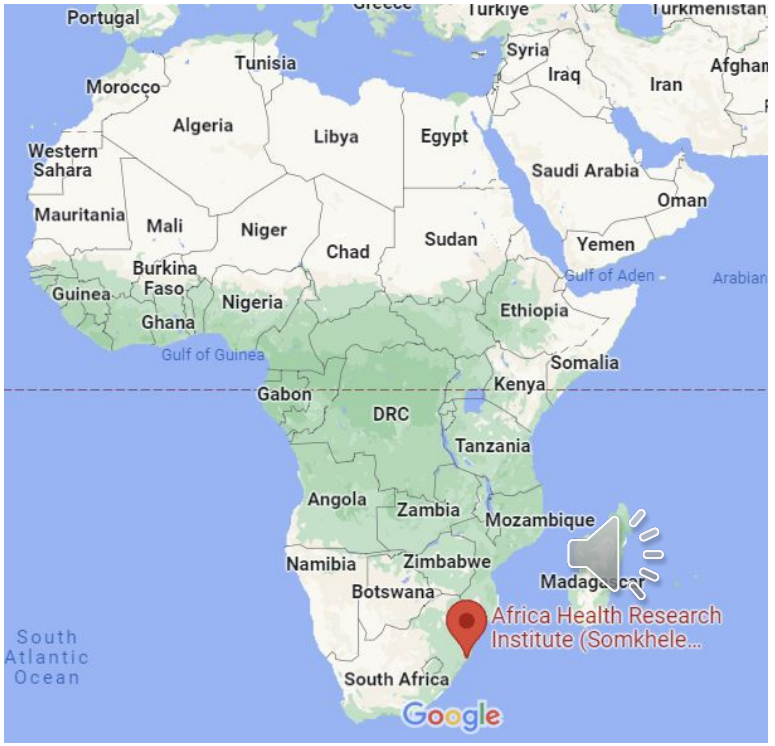
- ML is the “brain” of AI
- Commonest ML POCT algorithm “supervised learning”
- Machine is given “inputs” and these are associated with “outputs”
- When a new input is provided, the memory is scanned to identify the associated output.

Nat Med. 2021 July 01; 27(7): 1165–1170. doi:10.1038/s41591-021-01384-9.

Deep learning of HIV field-based rapid tests

Valérian Turbé[1], Carina Herbst[2], Thobeka Mngomezulu[2], Sepehr Meshkinfamfard[1], Nondumiso Dlamini[2], Thembani Mhlongo[2], Theresa Smit[2], Valeriia Cherepanova[3], Koki Shimada[3], Jobie Budd[1,4], Nestor Arsenov[1], Steven Gray[5], Deenan Pillay[2,6], Kobus Herbst[2,7], Maryam Shahmanesh[2,8], Rachel A. McKendry[1,4]

[1]London Centre for Nanotechnology, University College London, 17-19 Gordon Street, London WC1H 0AH, UK



Not too far, not too close

Too far

Too close

Capture all **4 white squares**

2 squares

3 squares

Take the picture **flat**

Avoid tilting the tablet

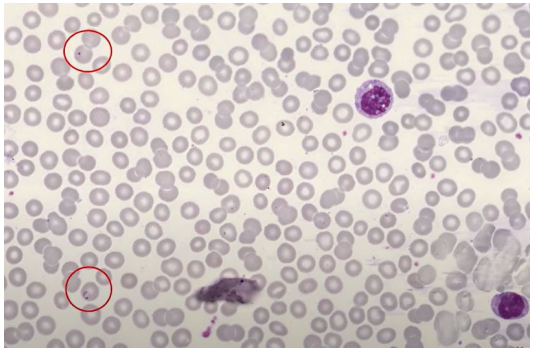
Focus

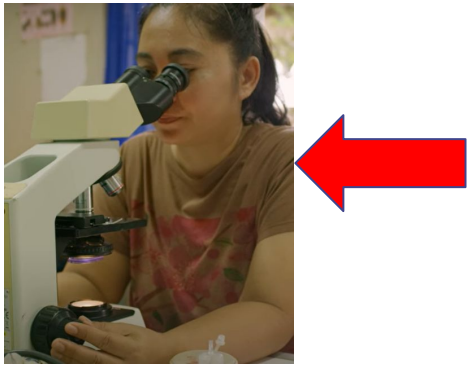
Blurry picture

Conclusions

- This pilot field study demonstrated:
  - Sensitivity (97.8%) and
  - Specificity (100%),
- Reduced the number of false positives and false negatives

AI and Malaria



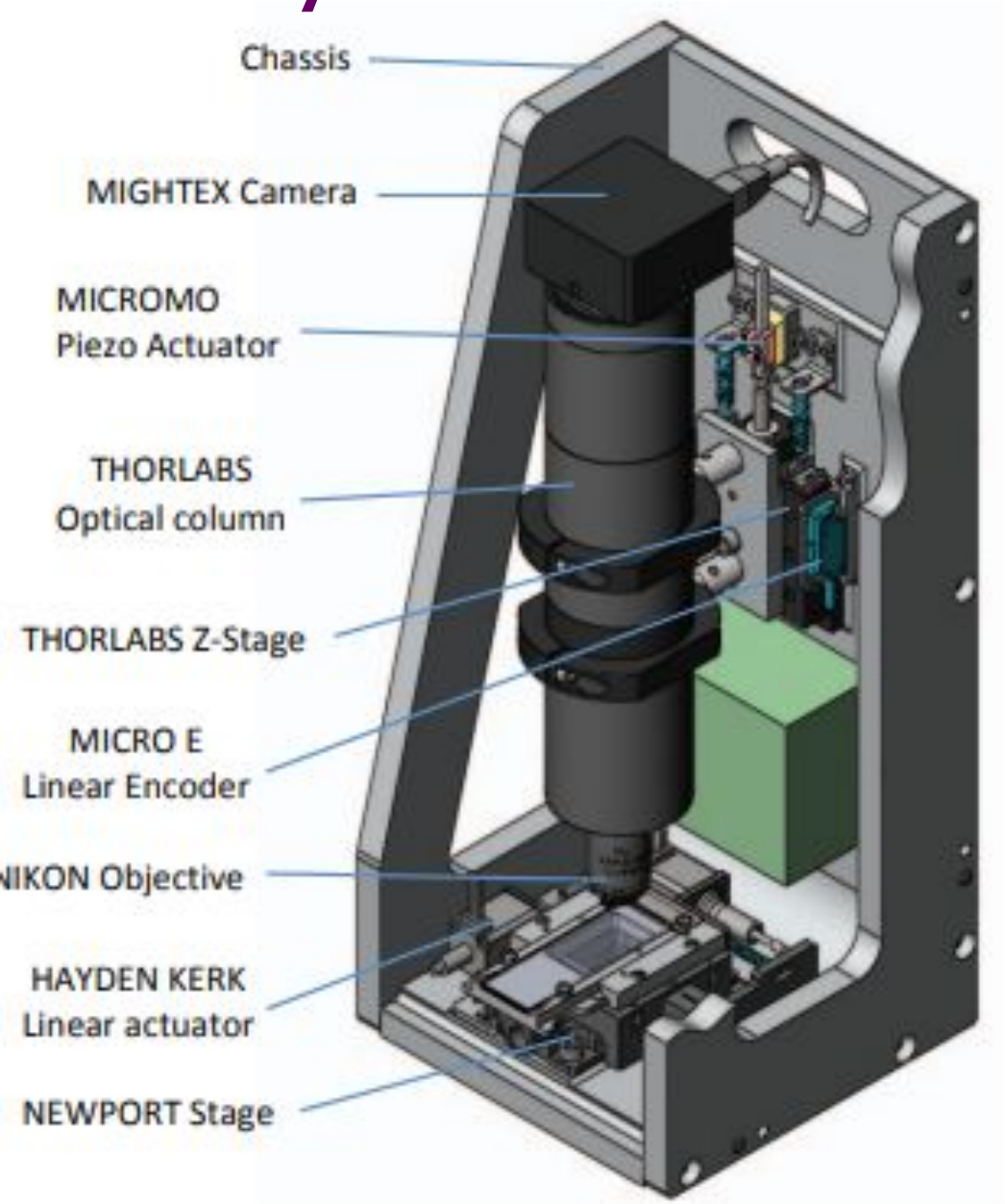


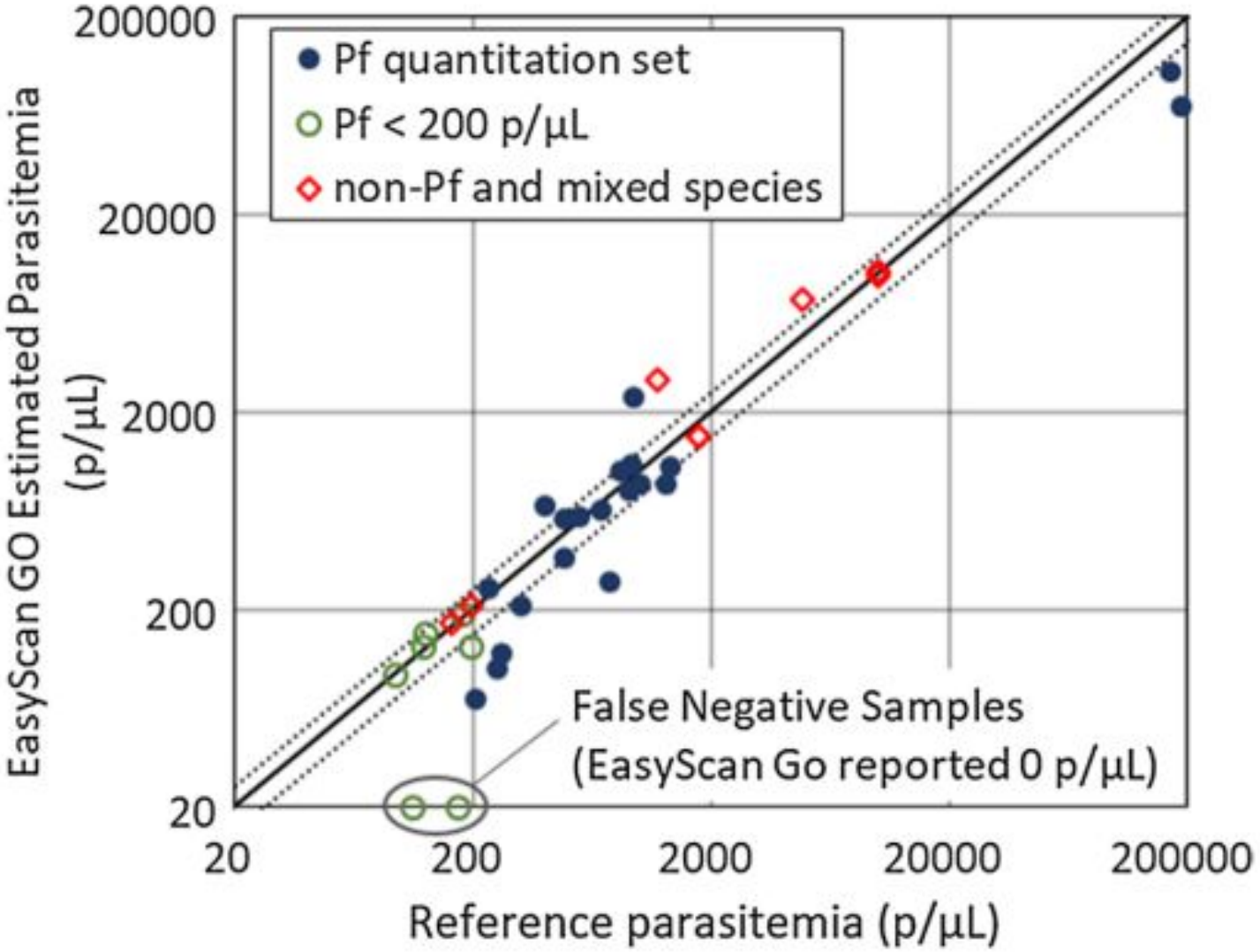
- Parasite presence
- Species
- Density of infection

Malaria Diagnosis

- Rapid diagnostics tests
  - Easy to use
  - Qualitative
  - Less sensitive and low infection density
  - Usually only specific for *P. falciparum*
  - Susceptible to false negatives
    - Hook Effect
    - Hrp2/3 gene deletion

EasyScan Go


Chassis
MIGHTEX Camera
MICROMO
Piezo Actuator
THORLABS
Optical column
THORLABS Z-Stage
MICRO E
Linear Encoder
NIKON Objective
HAYDEN KERK
Linear actuator
NEWPORT Stage



Horning et al. Malar J (2021) 20:110

Performance of the EasyScan GO using the WHO External Competence Assessment slide set

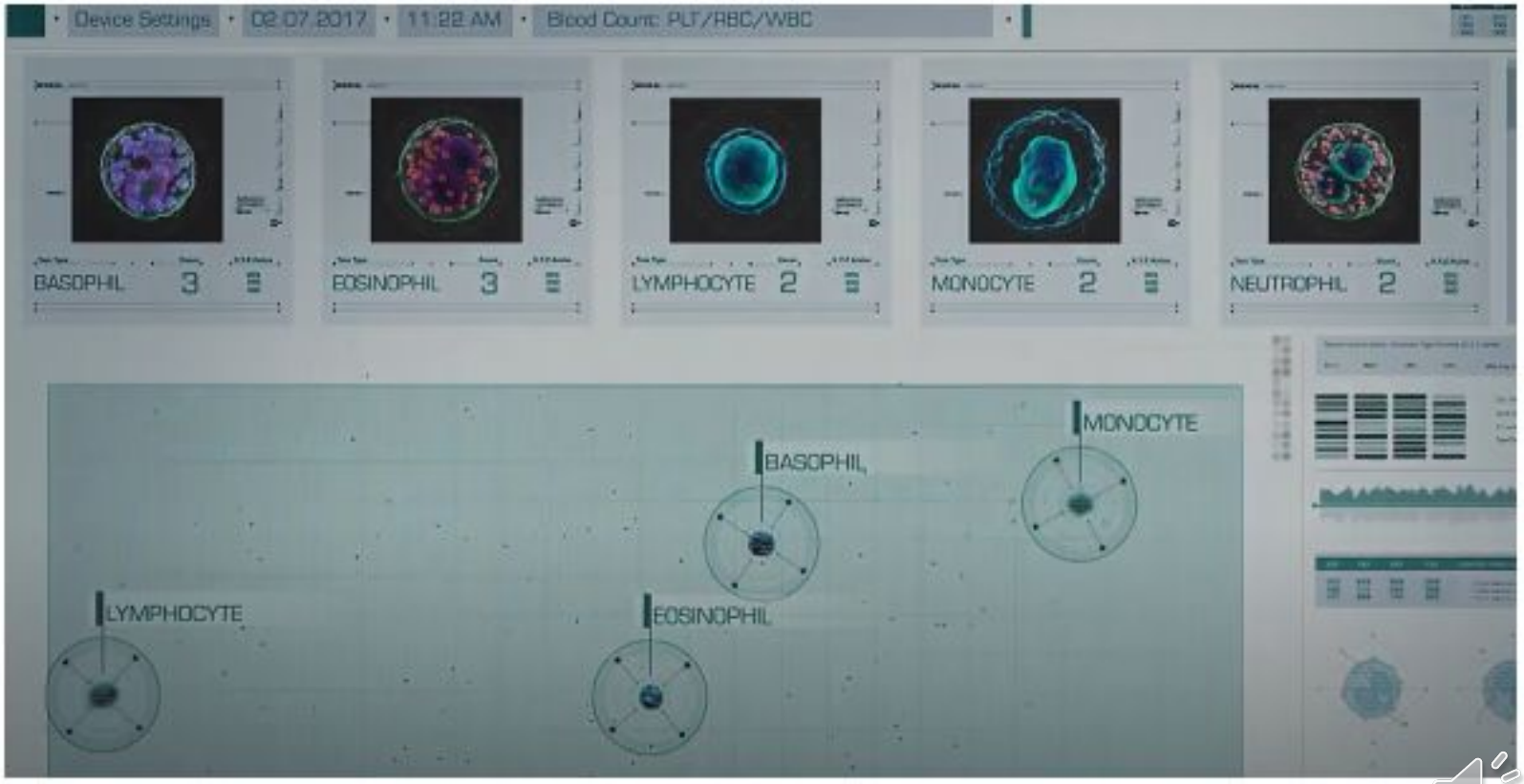
Component of assessment	Number of slides in subset	Numbe correct	Percentage correct	WHO level on this component
Detection	35	33	94.3	1
Species ID	35	29	82.9	2
Quantitation	20	10	50	1

Horning et al. Malar J (2021) 20:110

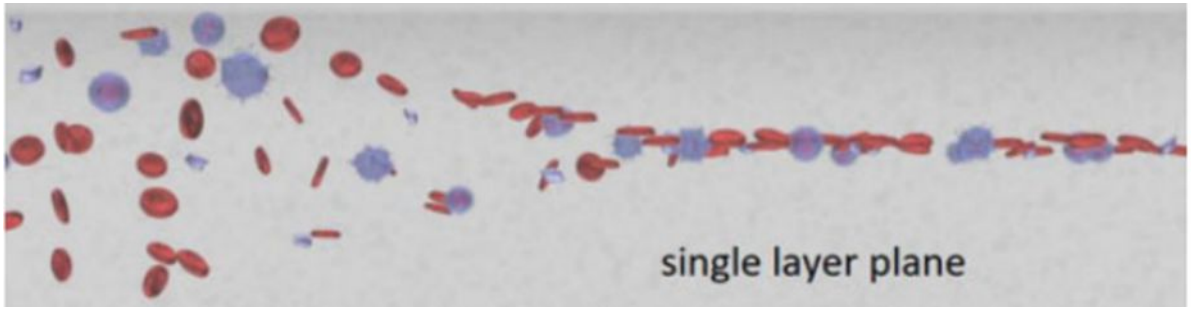
Conclusion

- It achieved:
  - Level 1 competence in Diagnosis and Quantitation
  - Level 2 in Species ID
- Best performance on this benchmark test by a fully-automated system

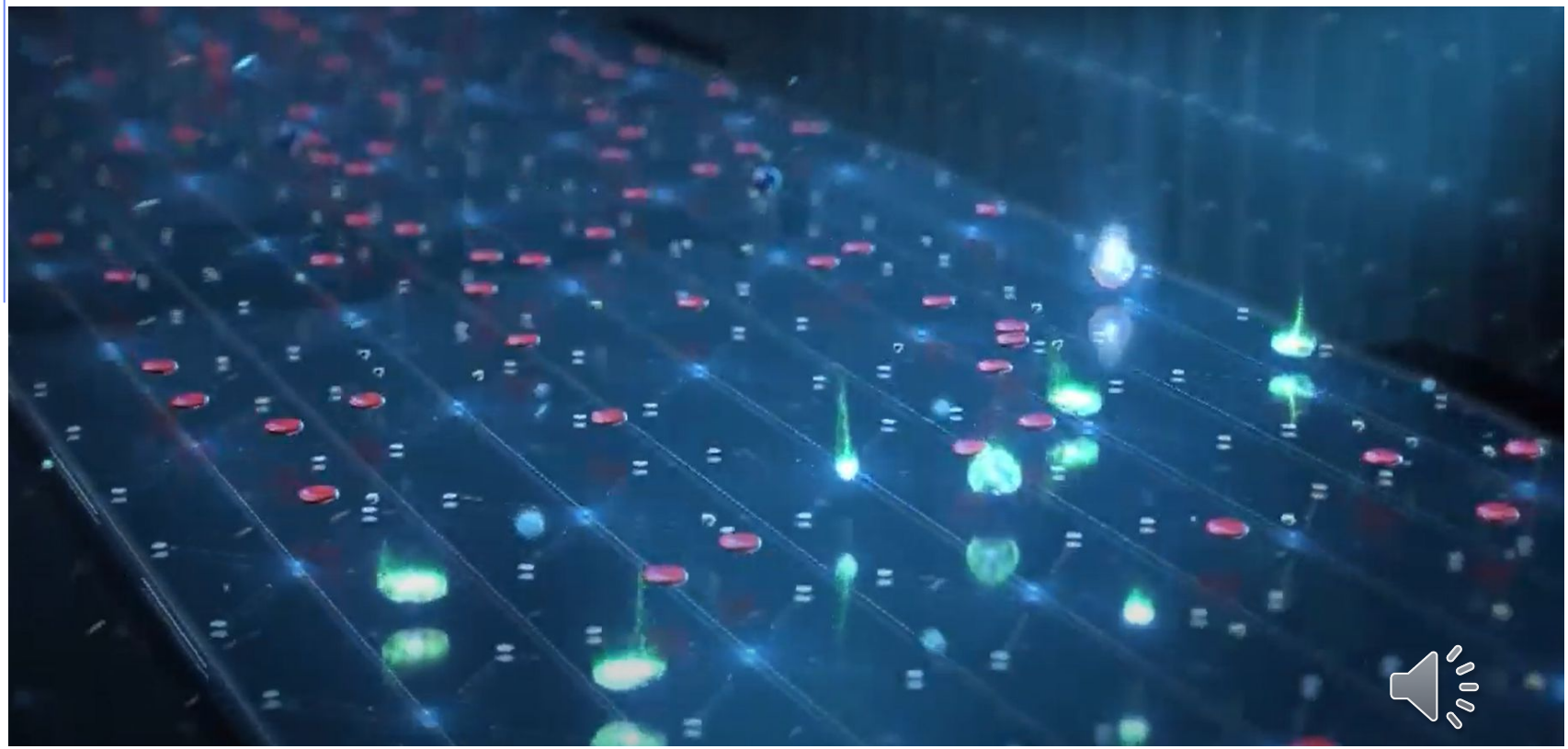
AI and POC Hematology



HemoScreen by PixCell Technologies



HemoScreen



Comparability with Sysmex XE-2100

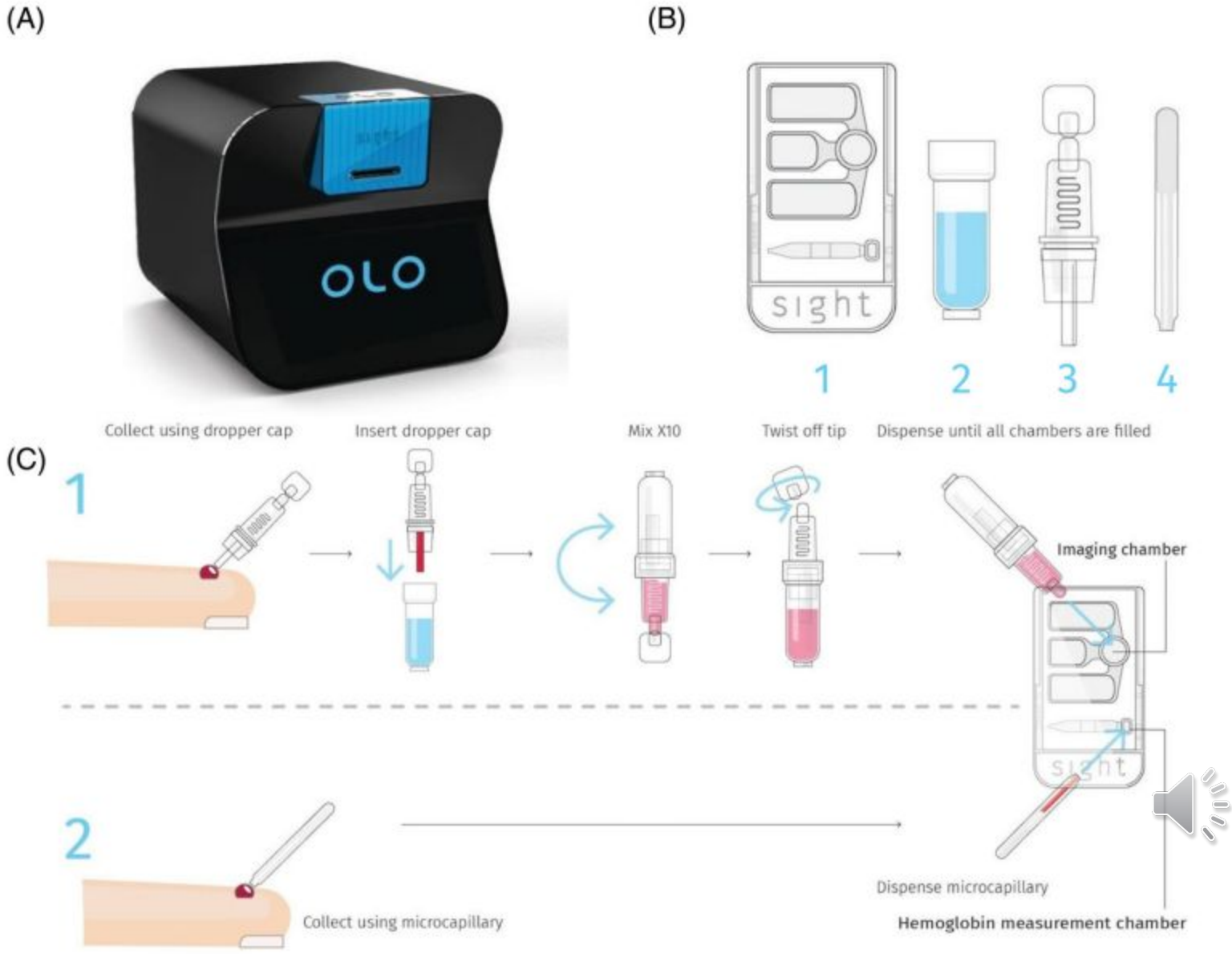
Table 2 Results of comparability study, the HemoScreen versus the Sysmex XE-2100

Parameter	N	Measurement ranges	Correlation coefficients (r)	Slope	Intercept
WBC ($\times 10^9$/L)	30	0.8–27	0.972 (0.941, 0.987)	0.813 (0.737, 0.89)	0.653 (−0.262, 1.568)
RBC ($\times 10^{12}$/L)	30	2.6–5.9	0.983 (0.965, 0.992)	0.953 (0.885, 1.022)	0.176 (−0.118, 0.47)
HGB (g/L)	30	79–172	0.980 (0.957, 0.990)	0.977 (0.9, 1.06)	0.076 (−9.05, 10.57)
HCT (%)	30	23.8–48.5	0.979 (0.956, 0.990)	1.009 (0.928, 1.09)	−0.530 (−3.58, 2.52)
MCV (fL)	30	73.4–107.5	0.932 (0.861, 0.967)	0.983 (0.835, 1.131)	1.155 (−12.011, 14.32)
MCH (pg)	30	21.2–36.2	0.959 (0.915, 0.981)	0.981 (0.869, 1.093)	0.159 (−3.172, 3.49)
MCHC (g/dL)	30	28.2–37.4	0.823 (0.657, 0.913)	0.800 (0.585, 1.011)	6.389 (−0.734, 13.511)
RDW (%)	30	11.7–24.2	0.923 (0.843, 0.963)	0.728 (0.610, 0.846)	3.28 (1.507, 5.051)
PLT ($\times 10^9$/L)	30	6–894	0.985 (0.968, 0.993)	1.085 (1.011, 1.16)	10.11 (−13.896, 34.116)
NEUT ($\times 10^9$/L)	30	0.05–24.1	0.970 (0.935, 0.985)	0.822 (0.741, 0.903)	0.312 (−0.474, 1.098)
LYMP ($\times 10^9$/L)	30	0.0–6.7	0.978 (0.953, 0.989)	0.939 (0.861, 1.017)	0.021 (−0.199, 0.158)
MONO ($\times 10^9$/L)	30	0.01–1.65	0.823 (0.653, 0.914)	0.865 (0.629, 1.101)	0.031 (−0.208, 0.147)
EOS ($\times 10^9$/L)	30	0.00–1.07	0.975 (0.947, 0.988)	1.024 (0.933, 1.115)	0.016 (−0.007, 0.038)
BASO ($\times 10^9$/L)	30	0.00–0.07	0.447 (0.088, 0.703)	3.569 (0.687, 6.451)	−0.051 (−0.134, 0.032)

BASO, basophils; EOS, eosinophils; HCT, haematocrit; HGB, haemoglobin; LYMP, lymphocytes; MCH, mean cell haemoglobin; MCHC, mean cell haemoglobin concentration; MCV, mean corpuscular volume; MONO, monocytes; NEUT, neutrophils; PLT, platelets; RBC, red blood cells; RDW, red blood cell distribution width; WBC, white blood cell.

Ben-Yosef Y, et al., J Clin Pathol 2016;69:720-5.

Sight Diagnostics – Sight OLO



Sight OLO

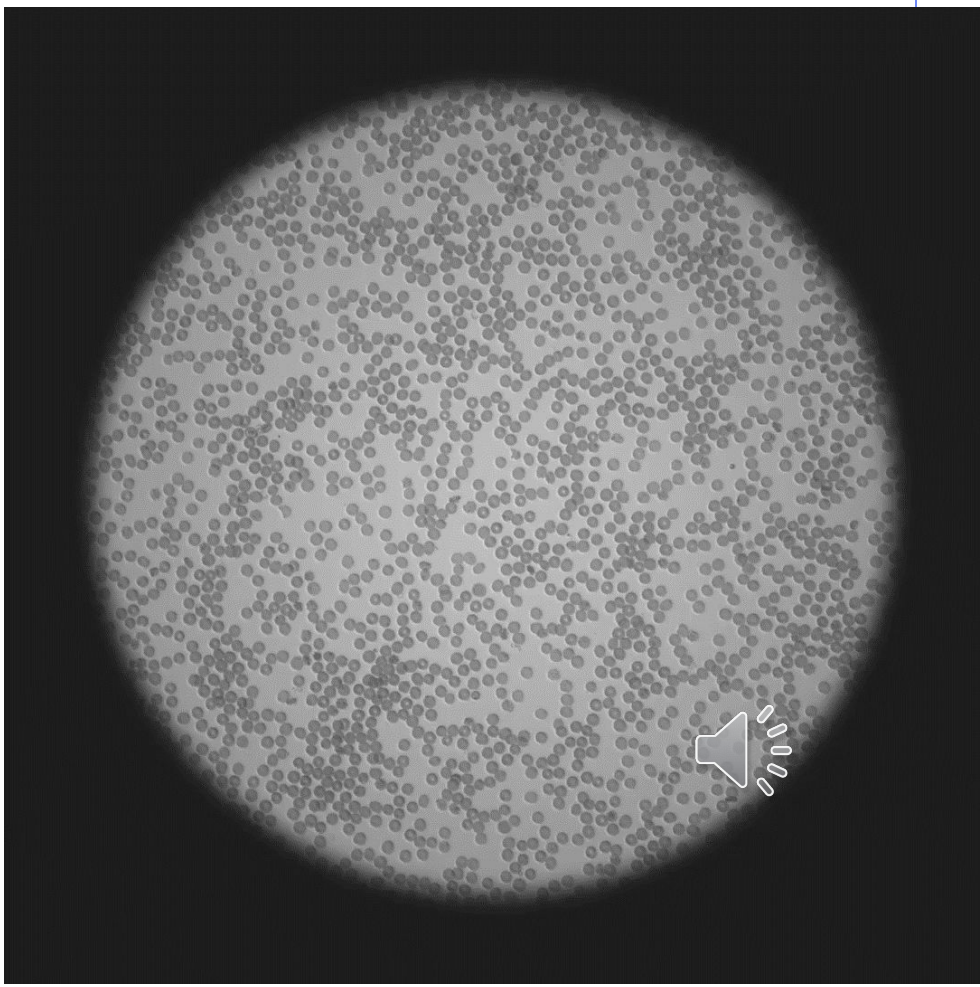
- Circumvents the problem of preparing a monolayer blood smear to identify cell types - how?

- Cells mixed with stains - drawn into the image chamber by capillary action, where they settle into a monolayer

- Imaged using the Sight OLO automated bright-field and fluorescence microscope

Sight OLO

- This captures thousands of multispectral images of a single blood specimen based on optical and chemical signatures
- And compares them to a library for correct identification

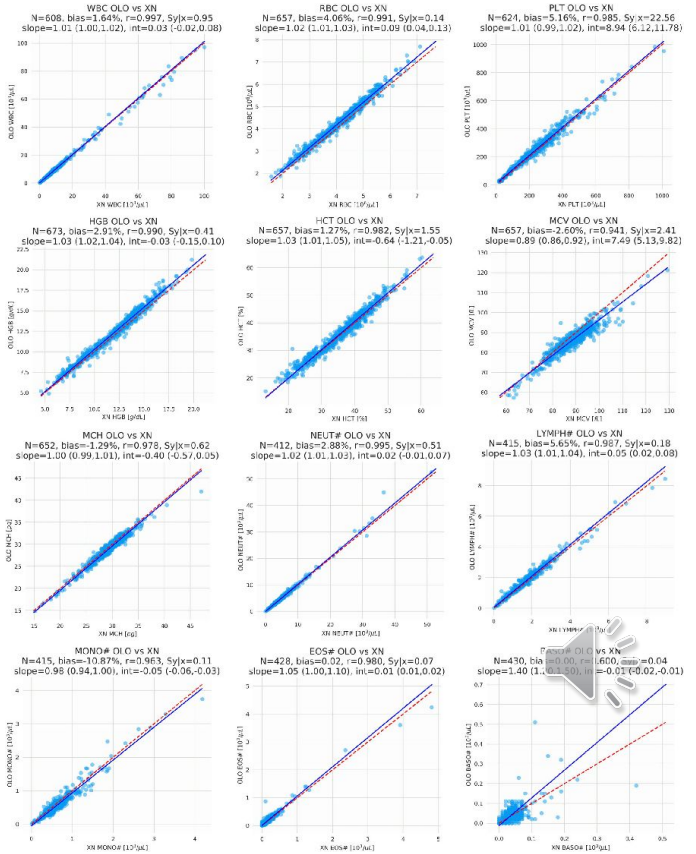


American Journal of Hematology AJH

An artificial intelligence-assisted diagnostic platform for rapid near-patient hematology

Bachar et al., . Am J Hematol 2021;96:1264-74.

Accuracy, repeatability, and flagging capabilities of OLO were compared with the Sysmex XN-Series System (Sysmex, Japan). **Regression analysis shows strong concordance between OLO and the Sysmex XN, demonstrating that OLO performs with high accuracy for all CBC parameters**. High repeatability and reproducibility were demonstrated for most of the testing parameters. The analytical performance of the OLO hematology analyzer **was validated in a multicenter clinical laboratory setting**, demonstrating its accuracy and comparability to clinical laboratory-based hematology



Take Home Points

- AI with POCT makes a powerful tool that can bridge the disparity gap in healthcare
- AI with POCT can ensure reliable results are being provided
- AI with POCT can empower communities to manage their diseases in their rural settings in a timely manner

THANK YOU - QUESTIONS?

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