EARLY WARNING DIAGNOSTICS FOR EMERGING INFECTIOUS DISEASES

AUGUST 29-30, 2022

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AFFILIATION/FINANCIAL INTERESTS (prior 12 months)	ENTITIES
Grants/Research Support	National Institutes of Health (NICHD, NIBIB) National Science Foundation US Department of Defense Global Alliance for Improved Nutrition United States Department of Agriculture United States Agency for International Development HarvestPlus/International Food Policy Research Institute World Health Organization
Scientific Advisory Board/Consultant/ **Board of Directors**	VitaScan
Speakers Bureau	N/A
Owner/Stock Shareholder	VitaScan
Employer	Cornell University
Other	N/A

OUTLINE

1. Disclosure

2. Early Warning Diagnostics

3. Examples from our work

4. FeverPhone as an Example of plug and play systems

5. Key Messages and Challenges

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ACCOUNTS
of chemical research

Article

Early Warning Diagnostics for Emerging Infectious Diseases in Developing into Late-Stage Pandemics

Published as part of the Accounts of Chemical Research special issue "Advances in Biosensor Technologies for Infection Diagnostics".

Taylor M. Oeschger, Duncan S. McCloskey, Rose M. Buchmann, Aakash M. Choubal, Juan M. Boza, Saurabh Mehta, and David Erickson*
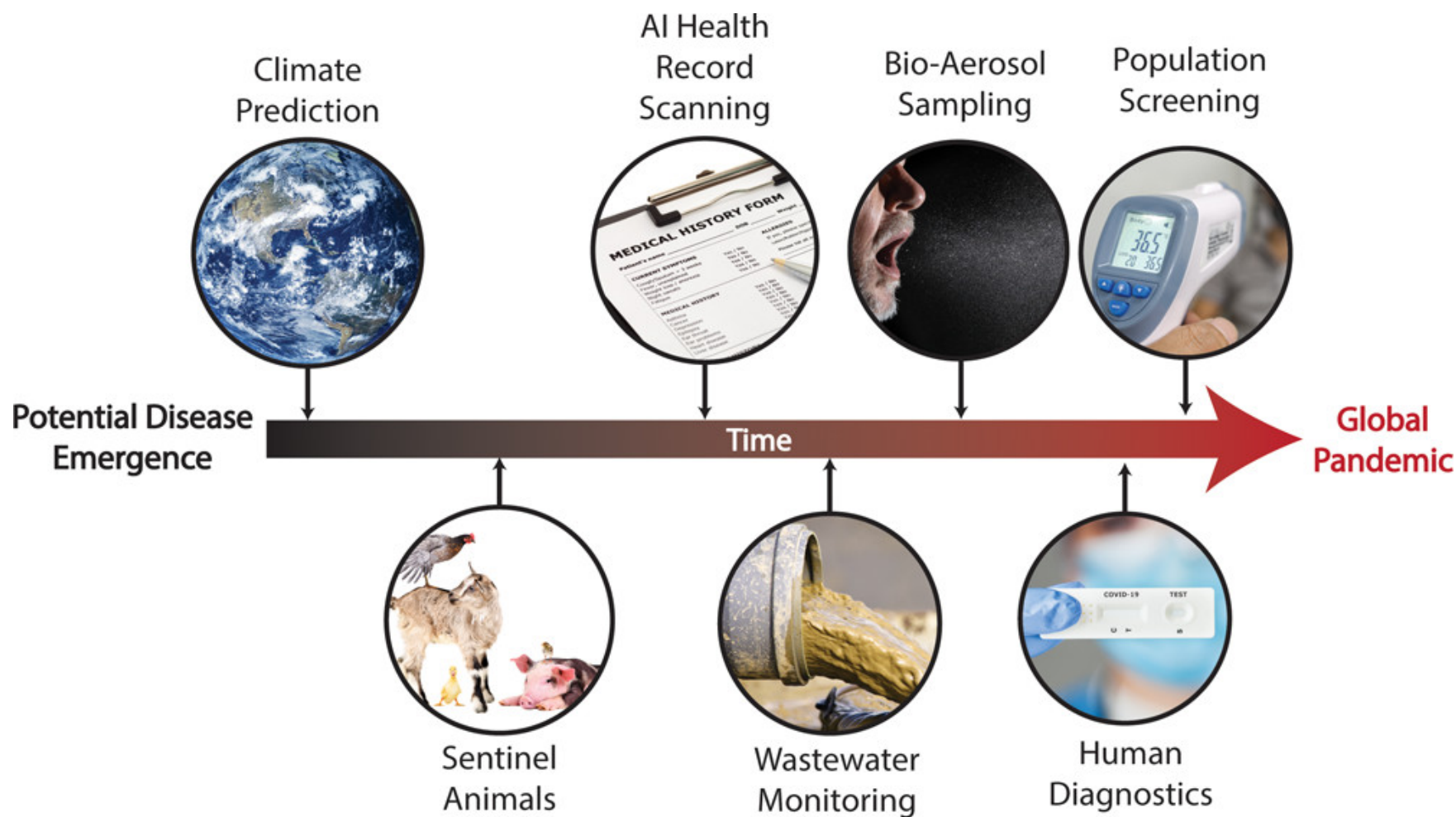
Figure 1. Timeline depicting point of implementation for various early warning systems

Oeschger TM, McCloskey DS, Buchmann RM, et al. Early Warning Diagnostics for Emerging Infectious Diseases in Developing into Late-Stage Pandemics. Accounts of Chemical Research. 2021;54(19):3656-3666.
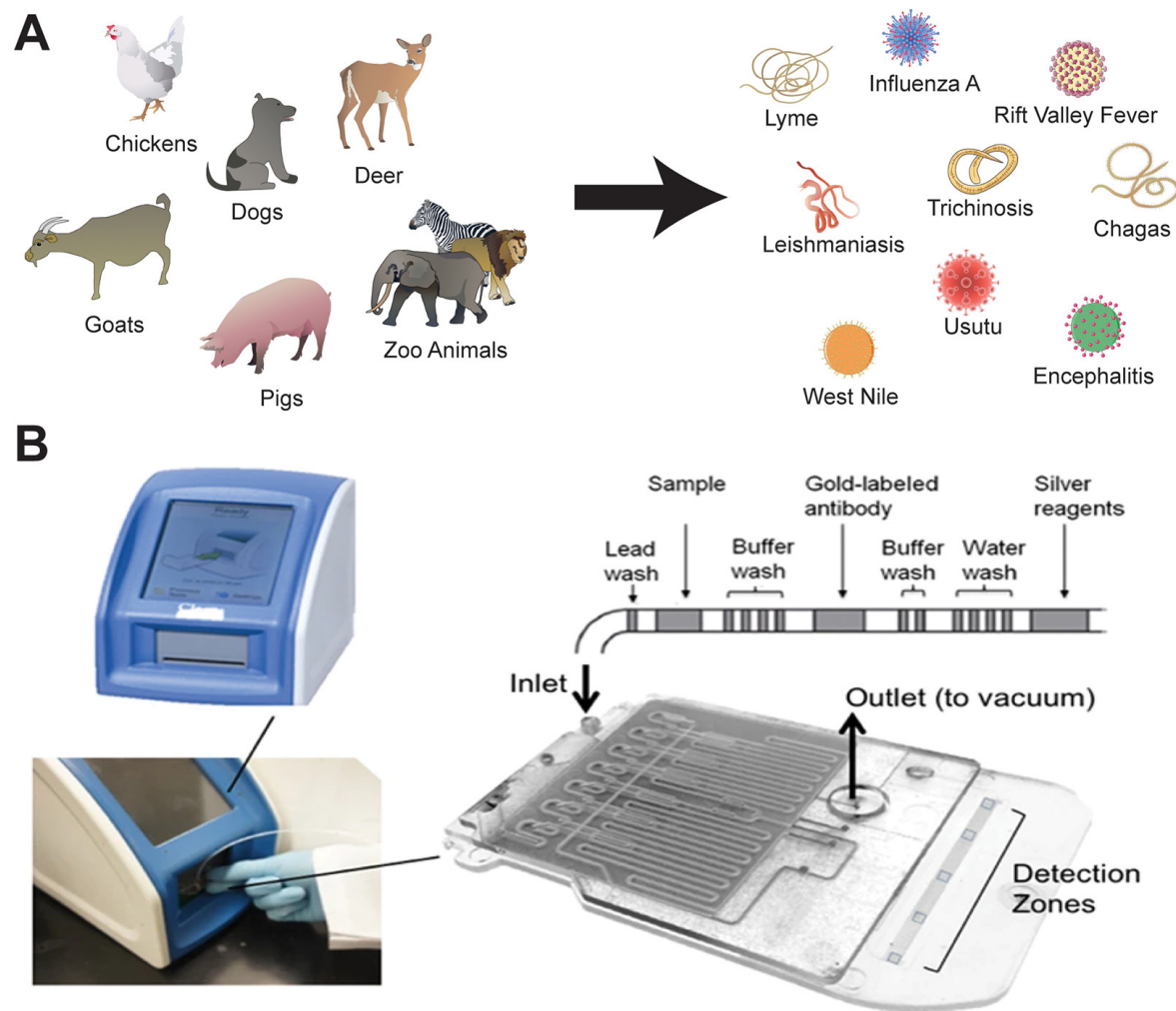
Figure 2. (A) Examples of sentinel animals and the corresponding human diseases they can be used to monitor. **(B)** Sample technology for microfluidic biochip for detecting Lyme antigens from sentinel animals using silver reagent precipitate and gold conjugated antibodies. Reproduced with permission from ref (25) . Copyright 2016 Springer Nature

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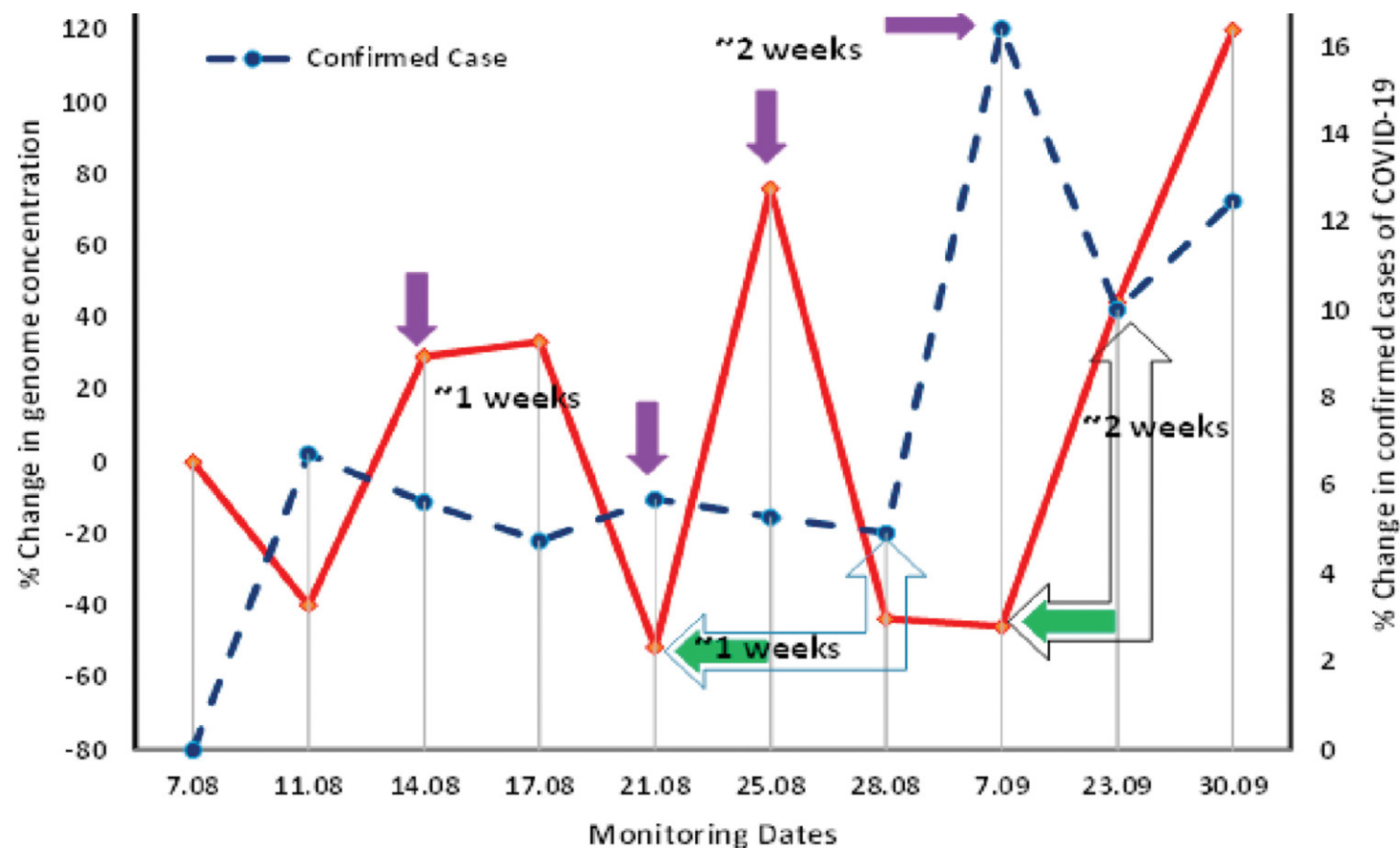
Figure 3. Graphical representation of detecting the SARS-CoV-2 virus in wastewater 1 to 2 weeks prior to the medically confirmed cases of COVID-19 in Gandhinagar, India. Reproduced with permission from ref (40). Copyright 2021 Elsevier Ltd.

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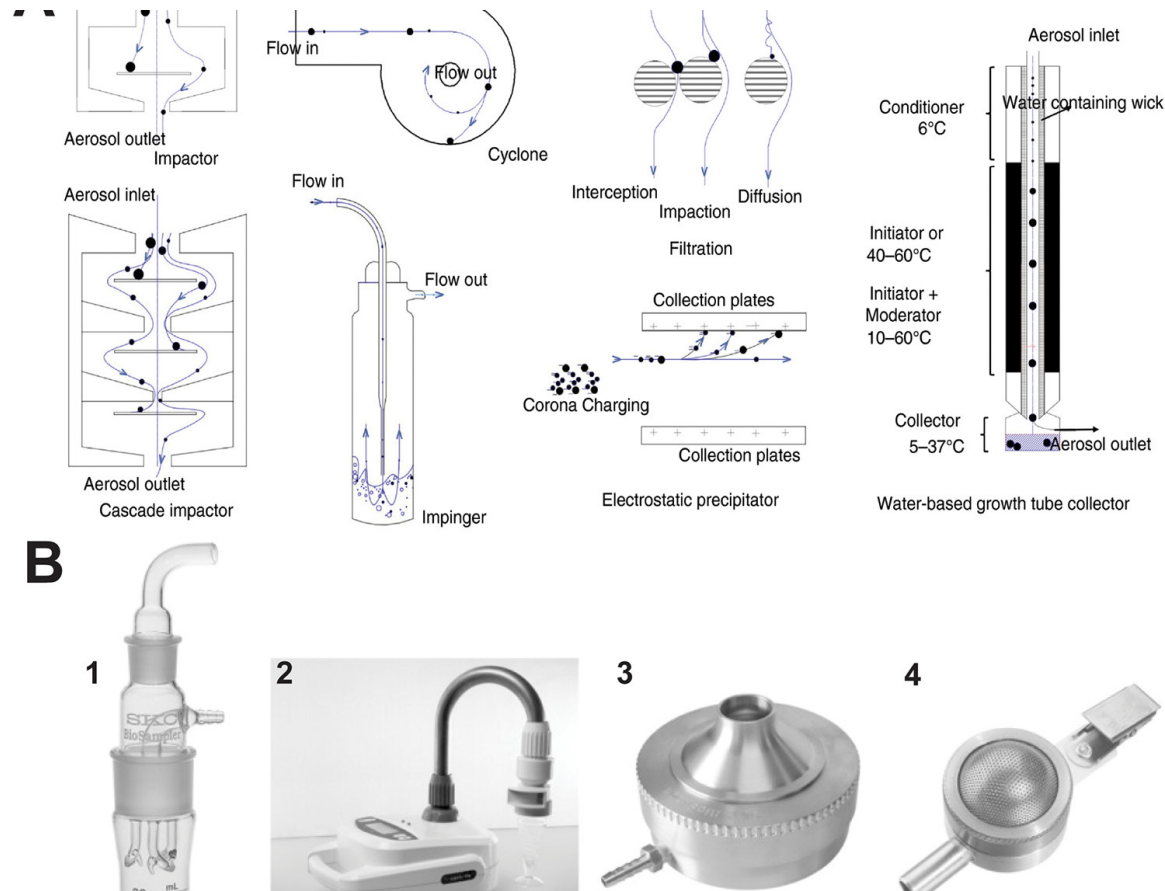
Figure 4. (A) Common systems for capturing bioaerosols. Reproduced with permission from ref (45) Copyright 2019 Springer Nature. (B) Bioaerosol samplers: (1) SKC impinger BioSampler, (2) Coriolis cyclone sampler, (3) SKC BioStage Impactor, and (4) SKC button filter sampler. Reproduced with permission from ref (50) . Copyright 2016 Elsevier Ltd.

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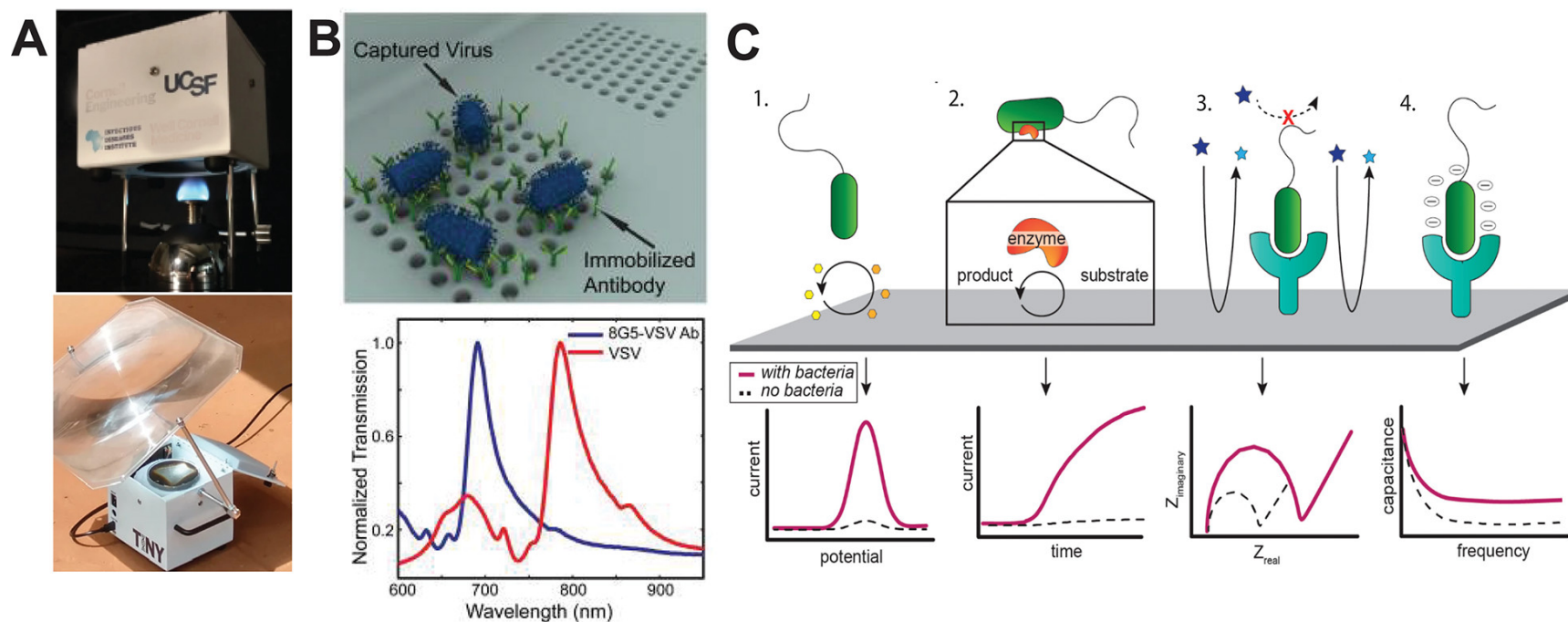
Figure 5. (A) Portable energy flexible isothermal nucleic acid amplification device for the field screening of viral diseases, shown here powered by flame and sunlight. Reproduced with permission from ref (1) Copyright 2018 Springer Nature. **(B)** Sample technology for label-free optofluidic sensing of viruses with the corresponding light transmission profile readout. Reproduced with permission from ref (69). Copyright 2010 American Chemical Society. **(C)** Examples of detection methods for electrochemical biosensors for bacterial (1) cell-secreted electroactive metabolites, **(2)** electroactive enzymatic products, **(3)** impedance from mediated electron transfer, and **(4)** surface dielectric properties. Reproduced with permission from ref (66) . Copyright 2020 American Chemical Society.

Oeschger TM, McCloskey DS, Buchmann RM, et al. Early Warning Diagnostics for Emerging Infectious Diseases in Developing into Late-Stage Pandemics. Accounts of Chemical Research. 2021;54(19):3656-3666.

FEVERPHONE

- COVID-19 Ag and IgG/IgM tests
- Dengue Virus Infection
- Malaria
- Chikungunya Virus
- Zika Virus
- Chagas
- Inflammation markers PCT/CRP

FeverPhone platform - includes a portable low-cost reader, mobile app for guiding the user and data handling, a custom-designed test strip for the infectious disease of interest

Colorimetric Differential Detection of Dengue and Chikungunya Viral Infections
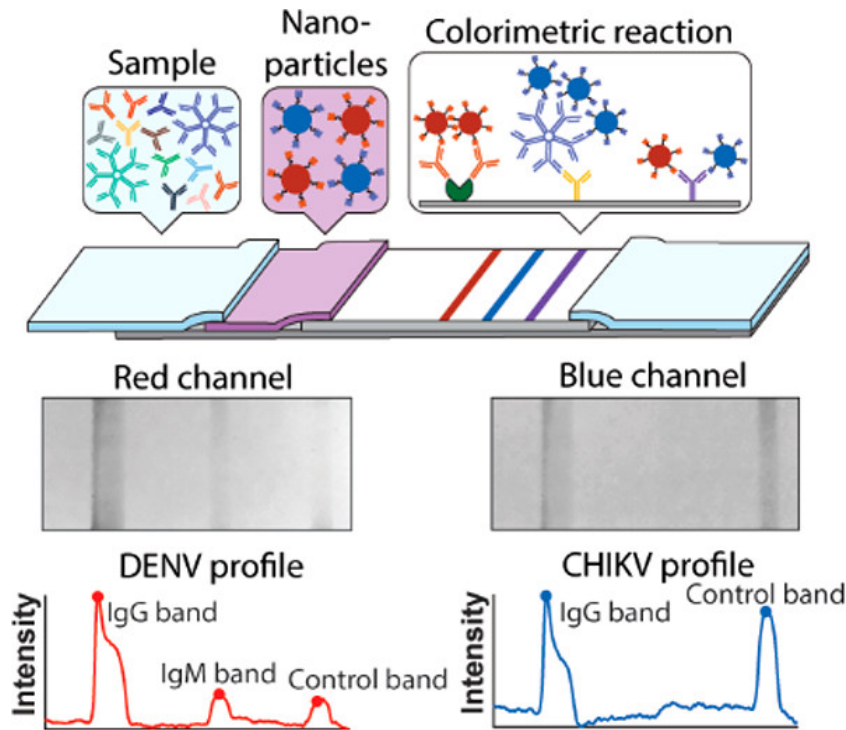

Architecture of multiplex lateral flow test strip. Red and blue nanoparticle conjugates are able to bind to DENV and CHIKV antibodies present in the sample, respectively
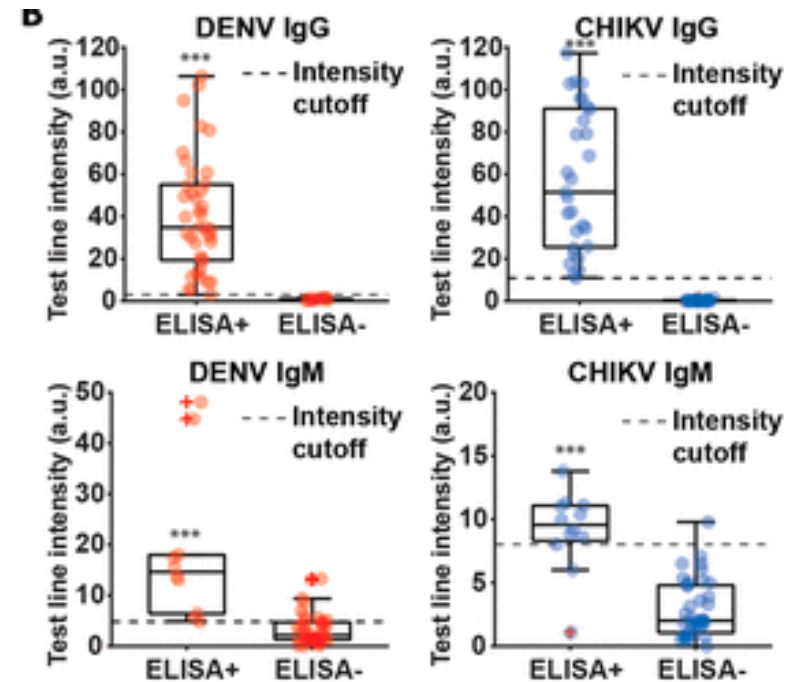

Test strip results for human samples from colorimetric data. Samples were tested in random order and in duplicate, and average test line intensities are shown as individual data points grouped by ELISA positive/negative classification. The optimal intensity cutoff, as subsequently determined through ROC curve analysis is represented by the horizontal dotted line.

Wang R, Ongagna-Yhombi SY, Lu Z, et al. Rapid Diagnostic Platform for Colorimetric Differential Detection of Dengue and Chikungunya Viral Infections. Analytical Chemistry. 2019;91(8):5415-5423.

Two-Color Duplex Platform for Point-of-Care Differential Detection of Malaria and Typhoid Fever
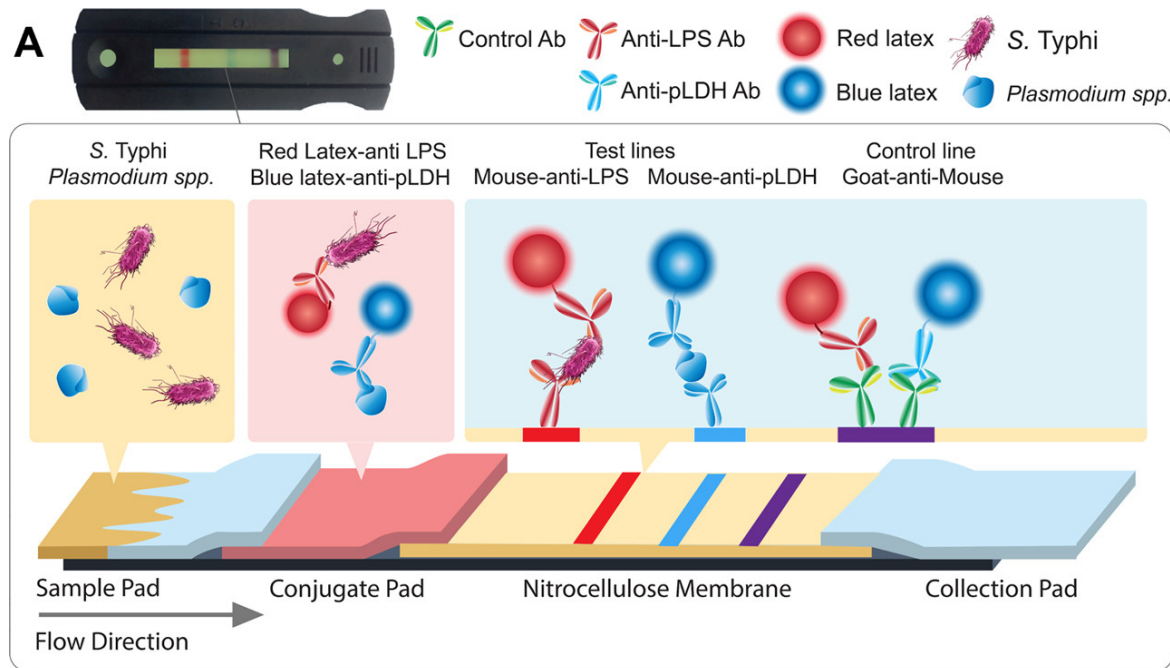

Schematics of a typhoid/malaria duplex LFA
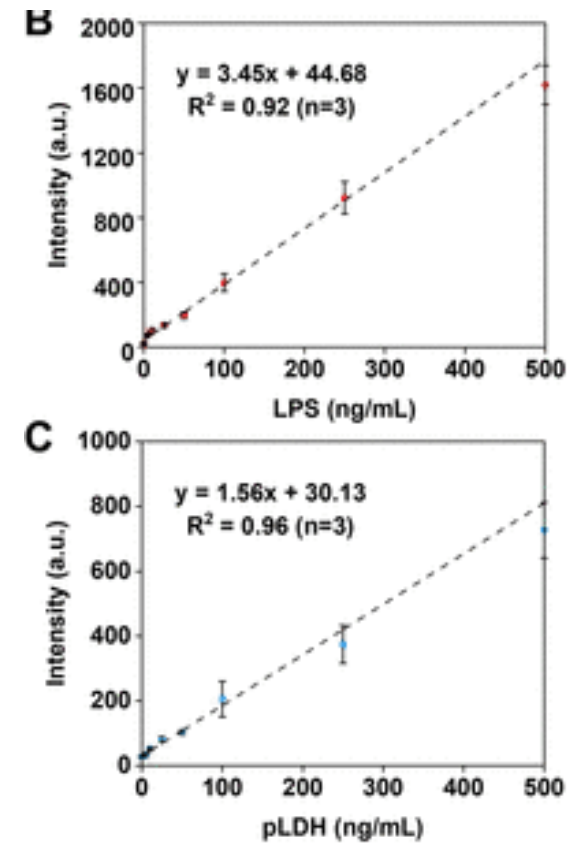
Calibration curve for LPS antigens with concentrations from 5 to 500 ng/mL.C) Calibration curve for pLDH antigens with concentrations from 5 to 500 ng/ mL.

Cao XE, Kim J, Mehta S, Erickson D. Two-Color Duplex Platform for Point-of-Care Differential Detection of Malaria and Typhoid Fever. Analytical Chemistry. 2021;93(36):12175-12180.

# COVID-19 Antigen and IgG/IgM test on FeverPhone platform
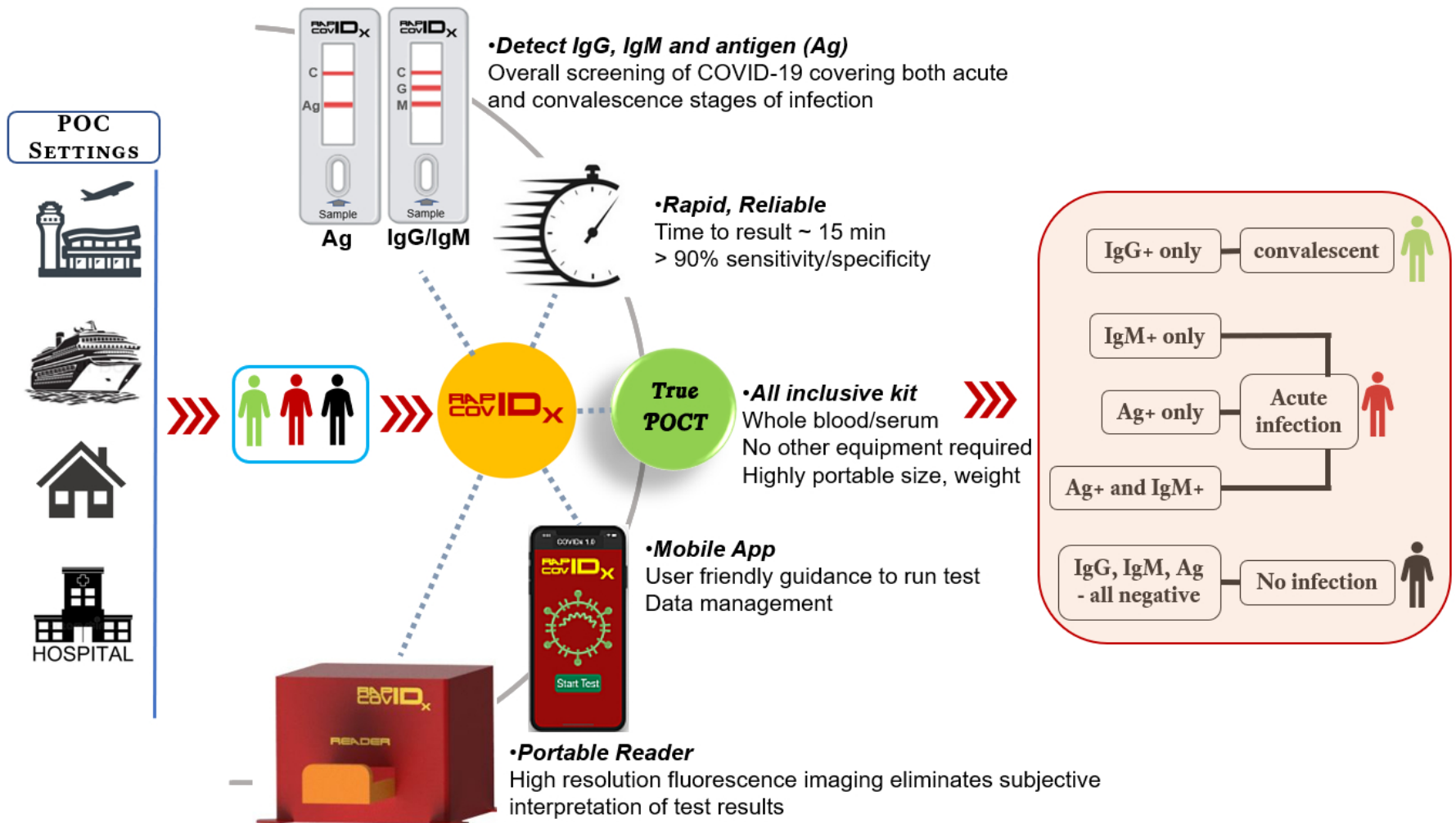
Features of RAPID COVIDx screening technology at point of care.

Validation with clinical samples in progress at Ecuador field site. Comparison of three types of nanoparticles as label for lateral flow assay.

TAKE HOME MESSAGES

1. Predictive technologies and animal monitoring can help identify areas of high risk, whereas non-invasive testing can occur at the community level, before minimally invasive individual and group sampling is required

2. Point of care diagnostic technology increases surveillance capacity in primary health care centers, low-economic status and remote areas

3. Technologies for human and animal health monitoring could be integrated with other surveillance systems at the community, country and global level to identify early warnings and vulnerable populations

4. This combination approach offers a framework for monitoring and minimizing potential infectious disease spread, ultimately reducing the tangible and intangible burdens of a future pandemic

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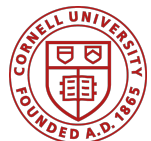
CHALLENGES

1. Point of care and other predictive technologies face adoption barriers such as regulatory approvals and policy development that allows local use outside of the research framework

2. Improve capacity for both development and manufacturing globally

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THANK YOU + ACKNOWLEDGMENTS

MEHTA RESEARCH GROUP

Global Health, Precision Nutrition, Epidemiology, and Diagnostics

EricksonLab
INTEGRATED MICRO- AND NANOFLUIDIC SYSTEMS

NIH
National Institutes of Health

NSF

DEPARTMENT OF DEFENSE · UNITED STATES OF AMERICA