MAY 06, 2020
CONFERENCE ONLINE

BIOSENSORS FOR PANDEMICS

Lateral flow devices for COVID-19-related biomarkers

Enric Calucho [a], José Francisco Bergua [a], Liming Hu [a], Celia Fuentes-Chust [a], Lourdes Rivas [a], Claudio Parolo [a], Ruslan Álvarez-Diduk [a] and Arben Merkoçi [a,b]

[a] Nanobioelectronics and Biosensors Group, Institut Català de Nanociència i Nanotecnologia (ICN2), Campus UAB, 08193 Bellaterra (Barcelona), Spain
[b] Institució Catalana de Recerca i Estudis Avançats (ICREA), 08010 Barcelona, Spain

Introduction

In December 2019, an outbreak of severe acute respiratory syndrome caused by a novel coronavirus (SARS-CoV-2) was originated in Wuhan, Hubei province, China, escalating into a global pandemic in just three months. The disease, officially named COVID-19, has saturated healthcare systems worldwide, thus demonstrating the urgent need to deploy rapid and reliable diagnostic tools. Along with contention measures such as social distancing and good hygienic practices, the use of diagnostic devices during the early stages of the pandemic can have a major impact on limiting the spread of the virus. In this context, lateral flow assays (LFAs) offer advantages compared to traditional techniques that depend on nucleic acid amplification due to their lower cost, shorter time of assay and ease of use. Most LFAs for COVID-19 diagnostic target immunoglobulins G and M (IgG/M) in blood for the assessment of acquired immunity against the virus. Alternatively, some LFAs target viral proteins of the SARS-CoV-2 structure, allowing for direct detection of the virus before the onset of symptoms. This poster will focus on: 1) a general outline on the operation of LFAs, 2) the two main approaches used during the current pandemic (IgG/IgM and viral protein detection), and 3) novel strategies, such as LFAs coupled to nucleic acid amplification.

Structure and biomarkers of SARS-COV-2

COVID-19 can be diagnosed immunologically by detection of its antigens (see SARS-COV-2 structure) or serologically by detection of IgG/M generated as an immune response. Both are compatible with a LFA approach. Moreover, after lysis of virus particles, viral RNA can be purified and amplified in order to be detected with CRISPR-based LFA strategies [1].

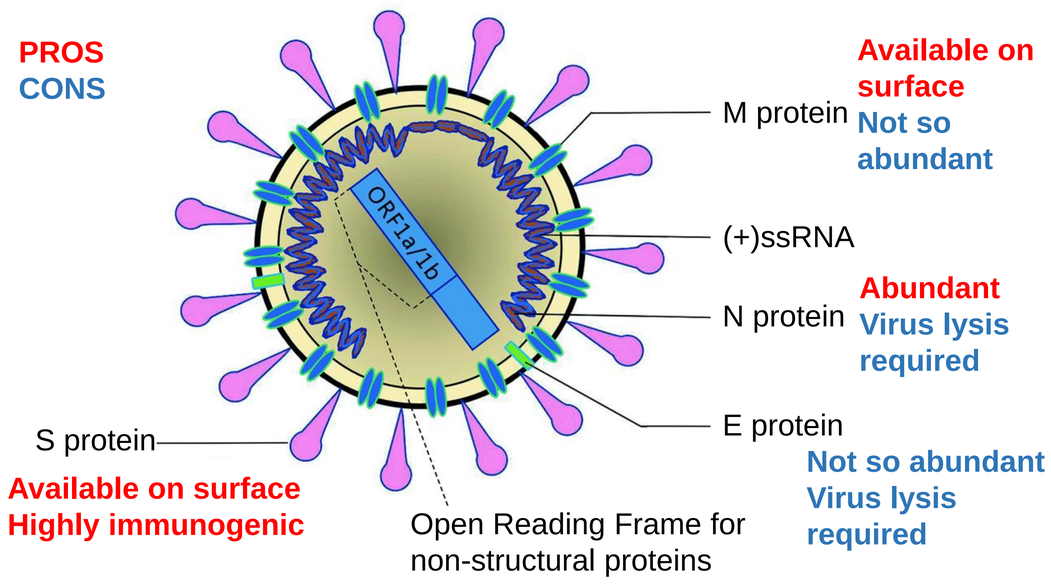

Figure 1. Structure of SARS-COV-2: S, spike protein; E, envelope protein; M, membrane protein; N, nucleoprotein. Structural proteins are typical biomarkers. Adapted from reference [2]. Permission not required. Copyright © 2020, Springer Nature.

Working principle of LFAs

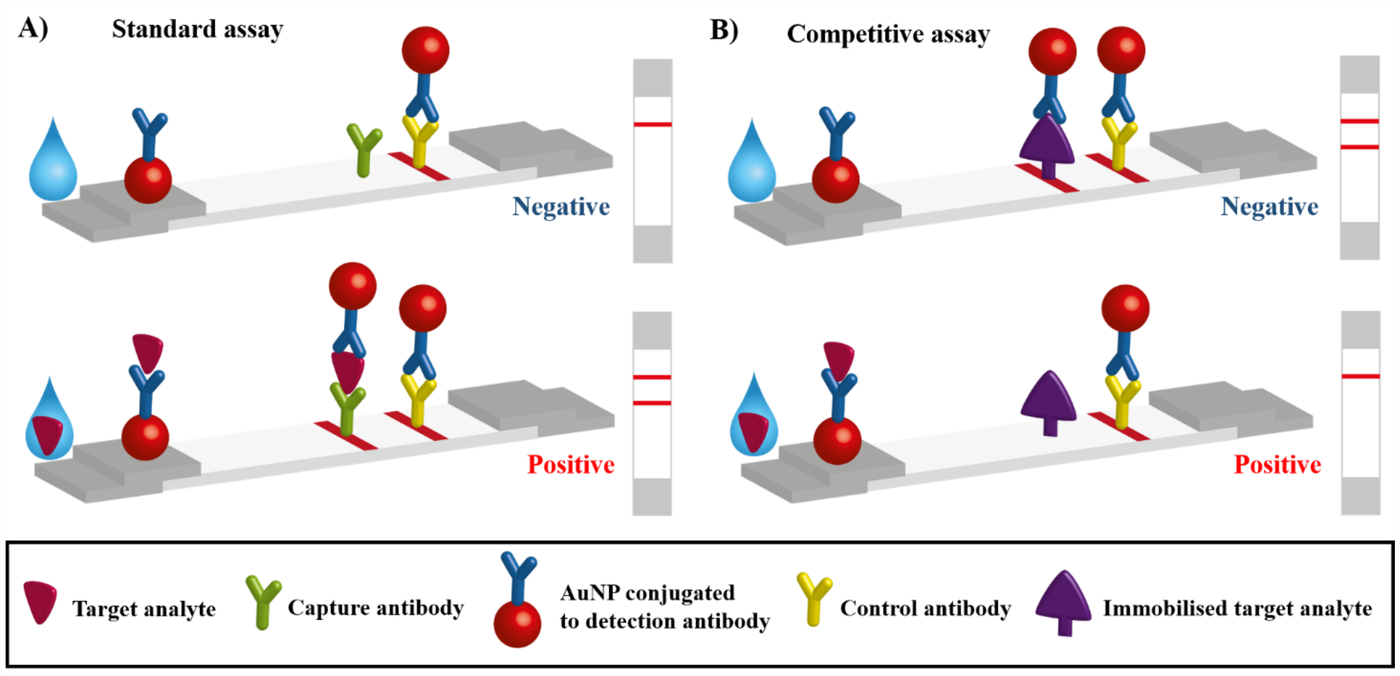

Figure 2. Schematic representation of typical LFA setups: standard (A) and competitive (B). Antibodies are depicted here as the typical bioreceptor, but aptamers and nucleic acid probes can also be implemented. Gold nanoparticles (AuNPs) are strongly red-coloured, easily fabricated in lab and cost-effective, making them the most used label in LFAs.

VS PCR

Advantages
- **Shorter time (15-30 min)**
- **Non-invasive sampling**
- **No trained personnel required**

Disadvantages
- **Less sensitive**
- **Mainly available for serological detection (false negatives due to late immune response)**

Serological LFA for COVID-19

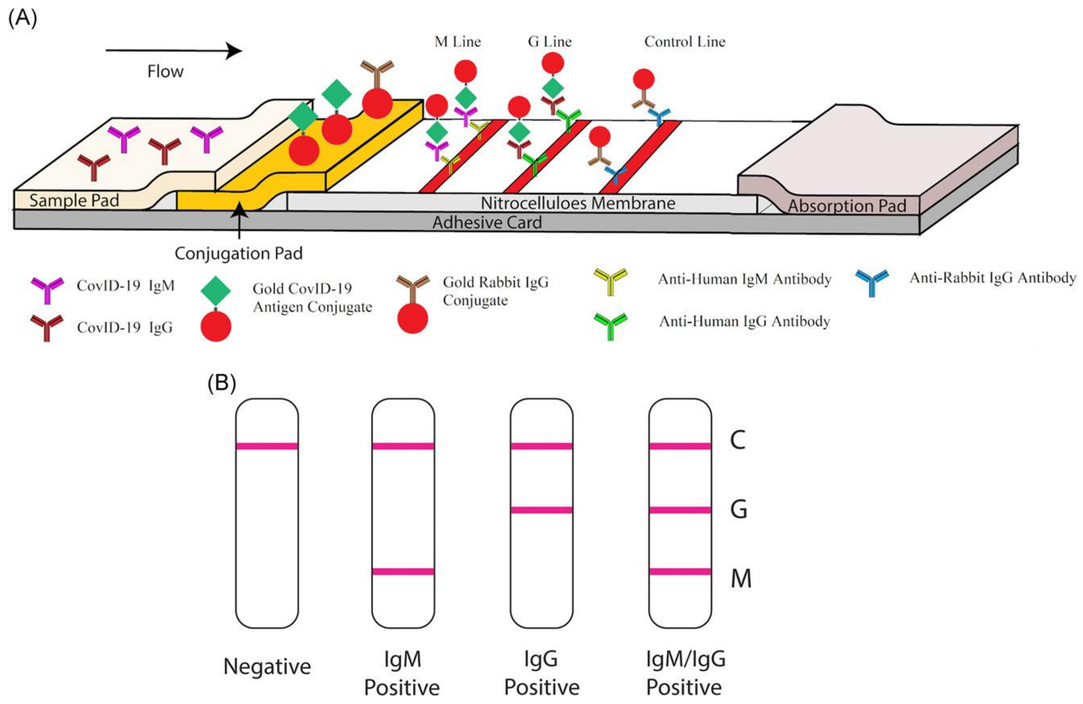

Figure 3. Antibodies generated by individuals as a result of SARS-COV-2 exposure can also be used as biomarkers of COVID-19. Adapted from reference [3]. Permission not required. Copyright © 2020, The Authors. Journal of Medical Virology published by Wiley Periodicals, Inc.

Types of LFAs for COVID-19 diagnostic (n=64) [4,5]

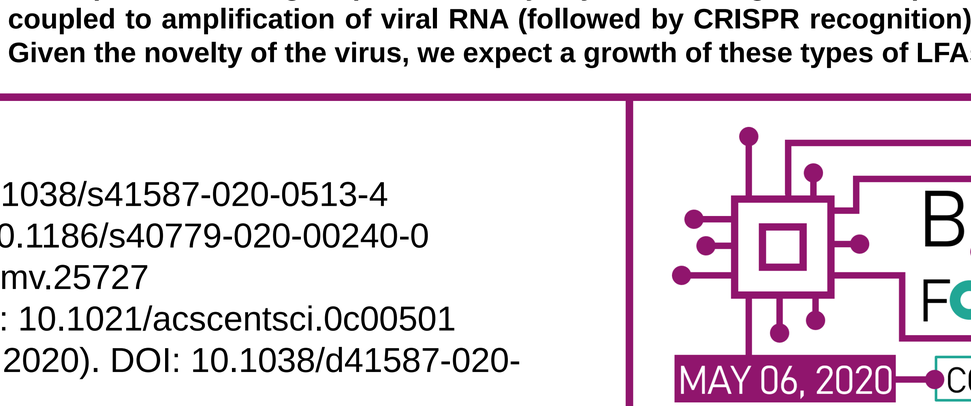

Figure 4. Distribution of LFAs for COVID-19 diagnostic according to their target analyte. Serological LFAs (detection of IgG/M) are the majority. Immunological LFAs (detection of antigens) and LFAs coupled to amplification of viral RNA (followed by CRISPR recognition) represent a smaller fraction. Given the novelty of the virus, we expect a growth of these types of LFAs diagnostic devices.

Perspective

LFAs will be a key element in the diagnosis challenge COVID-19 is proving to be. Thanks to their ease of deployment to hospitals and pharmacies and the compatibility with all of its biomarkers, LFAs can be adapted to both diagnosis and immunity assessment – during and after the outbreak.

CONTACT PERSON

Professor Arben Merkoçi
Email: arben.merkoci@icn2.cat

REFERENCES

[1] Nat. Biotechnol. (Letter), 2020. DOI: 10.1038/s41587-020-0513-4
[2] Military Med. Res., 2020, 7 – 11. DOI: 10.1186/s40779-020-00240-0
[3] J. Med. Virol., 2020, 1-7. DOI: 10.1002/jmv.25727
[4] ACS Cent. Sci., 2020, 6, 591 – 605 DOI: 10.1021/acscentsci.0c00501
[5] Nat. Biotecnol. News, (updated 17 April 2020). DOI: 10.1038/d41587-020-00010-2

BIOSENSORS FOR PANDEMICS
MAY 06, 2020 CONFERENCE ONLINE