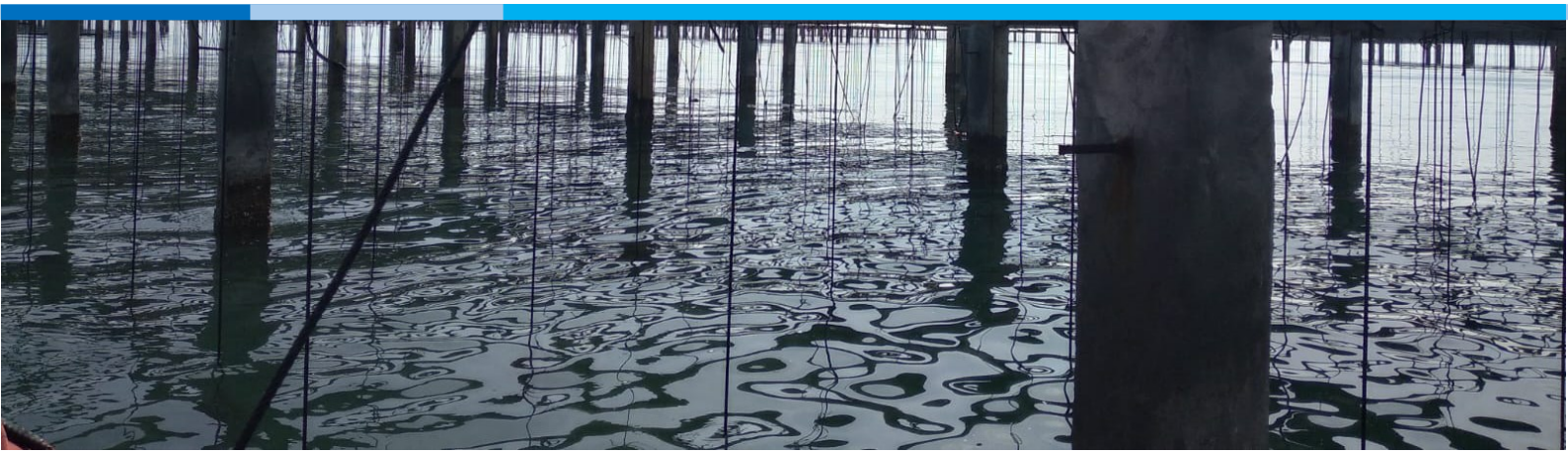
XXVIII TRANSFRONTIER MEETING ON SENSORS AND BIOSENSORS (TMSB2024)

BOOK OF ABSTRACTS

IRTA La Ràpita | 26 - 27 September 2024

XXVIII La Ràpita TMSB

IRTA RECERCA I TECNOLOGIA AGROALIMENTÀRIES



HOSTING INSTITUTION:

Institute of Agrifood Research and Technology (IRTA)

Ctra. Poble Nou, km 5.5

43540 La Ràpita

ORGANISING COMMITTEE:

Mònica Campàs

Jaume Reverté

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Mounira Alkassar

Sandra Leonardo

BENVINGUTS AL TMSB 2024!

Dear colleagues,

We are thrilled and honoured to welcome you to the 28th edition of the Transfrontier Meeting on Sensors and Biosensors (TMSB 2024). Established in 1996 by Prof. Salvador Alegret (Universitat Autònoma de Barcelona), Prof. Jean-Louis Marty (Université de Perpignan-Via Domitia), and Prof. Maurice Comtat (Université Paul Sabatier), TMSB was conceived with the goal of fostering collaboration among researchers from the Euroregion (Catalonia, Occitanie) working in the field of sensors and biosensors. Its primary mission is to create new partnerships and provide a platform for young scientists to share their work.

Over the years, TMSB has been hosted alternately by research groups from both sides of the border. This year, we are excited to hold the meeting at the Institute of Agrifood Research and Technology (IRTA) in La Ràpita, organised by the Biosensors group led by Dr. Mònica Campàs.

1 – Barcelona, 15-16 July 1996
2 – Céret, 18-19 September 1997
3 – Peníscola, 17-18 September 1998
4 – Montpellier, 16-17 September 1999
5 – Vic, 21-22 September 2000
6 – Toulouse, 20-21 September 2001
7 – Barcelona, 19-20 September 2002
8 – Céret, 18-19 September 2003
9 – Tarragona, 16-17 September 2004
10 – Albi, 15-16 September 2005
11 – Girona, 14-15 September 2006
12 – Céret, 27-28 September 2007
13 – Andorra-la-Vella, 18-19 September 2008
14 – Banyuls de la Marenda, 24-25 September 2009
15 – Sant Carles de la Ràpita, 16-17 September 2010
16 – Toulouse, 29-30 September 2011
17 – Tarragona, 20-21 September 2012
18 – Alès, 19-20 September 2013
19 – Barcelona, 25-26 September 2014
20 – Perpignan, 1-2 October 2015
21 – Barcelona, 29-30 September 2016
22 – Montpellier, 21-22 September 2017
23 – Barcelona, 19-20 September 2018
24 – Perpignan, 26-27 September 2019
25 – Sant Carles de la Ràpita (online), 30 September 2021
26 – Barcelona, 29-30 September 2022
27 – Banyuls de la Marenda, 28-29 September 2023
28 – La Ràpita, 26-27 September 2024

True to its spirit, TMSB offers a relaxed and friendly atmosphere, prioritising the participation of predoctoral researchers and young scientists, who will present their findings through at oral and poster sessions. We are confident that this meeting will spark fruitful scientific exchanges and deepen the connections between the research institutions involved.

We look forward to an inspiring and productive event!

Mònica Campàs
on behalf of the Organising Committee

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SCIENTIFIC AND SOCIAL PROGRAMME

XXVIII Transfrontier Meeting on Sensors and Biosensors (TMSB 2024)		
Scientific and Social Programme		
Thursday 26th September		
14:00 – 14:50	**Registration and Poster Installation**	
14:50 – 15:00	**TMSB2024: Opening Session**	
15:00 – 16:30	**Oral Presentations: First Session** Biorecognition Elements for Biosensing Chairman: **Thierry Noguer (UPVD)**	
15:00 – 15:30	**Anna Toldrà (KI)** Decentralizing nucleic acid tests: Towards integrated devices using paper, textile and electronics	**KN 01**
15:30 – 15:45	**Shaira Jane Acosta (URV)** *In vitro* selection of DNA aptamers for highly specific recognition of *Mycobacterium tuberculosis* ESAT-6/CFP-10 heterodimer antigen	**OC 01**
15:45 – 16:00	**Elena Rodríguez-Franch (UAB)** Improving cocaine voltammetric detection with molecularly imprinted polymer modified sensor	**OC 02**
16:00 – 16:15	**Jaume Reverté (IRTA)** The importance of antibody cross-reactivity in immunoanalytical tools for toxins	**OC 03**
16:15 – 16:30	**Mounira Alkassar (IRTA)** Neuroblastoma cell-based tools and HPLC-FLD for the detection of paralytic shellfish toxins in marine pufferfish from the Spanish Mediterranean coast	**OC 04**
16:30 – 17:15	**Coffee break** **Poster Session (PC 01 – PC 21)**	
17:15 – 18:15	**Oral Presentations: Second Session** New Materials and Sensor Platforms Chairwoman: **Mar Puyol (UAB)**	
17:15 – 17:30	**Franc Paré (UAB)** 3D-printing technology for unconventionally shaped electrode's fabrication	**OC 05**
17:30 – 17:45	**Deepanshu Verma (ICIQ)** Porous alumina-based biosensing platforms for early-stage infection diagnosis	**OC 06**
17:45 – 18:00	**Roger Serentill-Grau (UAB)** Development of electrochemical sensors with 3D printing technology for the analysis of illicit substances	**OC 07**
18:00 – 18:15	**Marwa Ben Amar (IMB-CNM)** Smart analytical microtechnology for aquaculture process monitoring	**OC 08**
20:00	**Gala Dinner** **Restaurant Juanito Platja** *Passeig Marítim, 50, 43540 La Ràpita* *(Scan the QR code for on-screen map instructions)*	

XXVIII Transfrontier Meeting on Sensors and Biosensors (TMSB 2024)		
Scientific and Social Programme		
Friday 27th September		
09:00 – 10:00	**Oral Presentations: Third Session** Portable Devices for Point-of-Care Applications Chairman: **Julio Bastos-Arrieta (UB)**	
09:00 – 09:30	**Manuel Gutiérrez-Capitán (IMB-CNM)** Point-of-care (PoC) devices based on multiplexed electrochemical biosensors for early disease diagnosis	**KN 02**
09:30 – 09:45	**Anaixis del Valle (UAB)** Portable PCR and electrochemical genosensing for the rapid screening test development to detect neonatal *Streptococcus agalactiae* infections	**OC 09**
09:45 – 10:00	**Juan Carlos Porras (UAB)** Portable medical device based on magneto immunosensor for the diagnosis of celiac disorder	**OC 10**
10:00 – 10:45	**Coffee break** **Poster Session (PC 01 – PC 21)**	
10:45 – 11:30	**Oral Presentations: Fourth Session** Sensing Tools for Emerging Contaminants Chairwoman: **Beatriz Prieto-Simón (ICIQ)**	
10:45 – 11:00	**Youssef Ali (CNIEL, ANSES)** Colorimetric and electrochemical enzymatic biosensor for the detection of disinfectants in dairy products	**OC 11**
11:00 – 11:15	**Jing Huang (UB)** Electrochemical determination of emerging contaminants using tailored layer-by-layer modification of screen-printed carbon electrodes	**OC 12**
11:15 – 11:30	**Ulises Guillermo Díaz Avello (URV, IRTA)** Accurate and fast tetrodotoxin detection by a paper-based test based on an antibody-aptamer sandwich assay	**OC 13**
11:30 – 11:45	**Final Remarks and TMSB2024 Awards**	
12:00 – 16:00 (tentative)	**Boat Excursion and Closure Lunch** **Musclarium** *Badia dels Alfacs, Port Esportiu, 43540 La Ràpita* *(Scan the QR code for on-screen map instructions)*	

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LIST OF POSTERS

XXVIII Transfrontier Meeting on Sensors and Biosensors (TMSB 2024)	
List of Posters	
PC 01	**Jennifer Marfà (UAB)** Integration of molecularly imprinted polymers into paper-based nucleic acid lateral flow platforms for enhanced multiplexed point-of-need diagnostics
PC 02	**Alexandros Lazanas (ICIQ)** Coupled size-exclusion and electrocatalytic activity of CuO QDs functionalized porous silicon electrodes directly used in human saliva
PC 03	**Rafael C. Hensel (UAB, USP)** Laser-induced graphene electrodes for wearable sweat sensors
PC 04	**Xavier Cetó (UAB)** Inkjet-printed sensor array for the simultaneous detection of drugs of abuse adulterants
PC 05	**Jaume Reverté (IRTA)** The BLUESHELLFISH project: Combination of toxicological and structural-recognition data for ciguatera risk assessment
PC 06	**Maria Trachioti (ICIQ)** Development of 3D-printed micropillar-based electrochemical sensors
PC 07	**Eva Arasa-Puig (UAB)** Microanalyzer for pH determination in wine
PC 08	**Marta Meneghello (UPVD)** Development of a biosensor to detect cellular heterogeneity during fermentation
PC 09	**Laia Garrido Carretero (UAB)** Towards the industrialization of disposable biomedical devices for at-home use
PC 10	**Laia Garrido Carretero (UAB)** Disposable device for at-home alanine blood monitorization for controlling mitochondrial diseases
PC 11	**Fearghal O'Connor (URV, ICIQ)** Porous silicon-based sensor to detect and monitor biofilm growth
PC 12	**Martina Tolós (IRTA)** Visual test for the detection of γ-glutamyl transpeptidase in calf serum
PC 13	**Antonio Calvo-López (IRSJD)** Characterization of microfluidic platforms for their application in assisted reproduction processes
PC 14	**Antonio Calvo-López (IRSJD)** Cadmium monitoring using automated microanalyzers in the hydrometallurgical production of zinc
PC 15	**Antonio Calvo-López (IRSJD)** Cobalt monitoring in the hydrometallurgical production of zinc using an automated spectrophotometric microanalyzer
PC 16	**Olga Melisidou (UAB)** Evaluating the capability of pentamethincynanines as bactericides

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List of Posters	
PC 17	**Melania Mesas (UAB)** Traffic light-based point-of-care test for the rapid stratification of fever syndromes
PC 18	**Julio Bastos-Arrieta (UB)** The evolving landscape of electroanalysis at the University of Barcelona
PC 19	**Ambbar Aballay-González (UdeC)** Detection of saxitoxin using an immunodetection tool based on magnetic beads
PC 20	**Yudong Bian (UAB)** Biochar based sustainable electrochemical screen-printed carbon sensors for environmental analysis: a perspective approach
PC 21	**Rosanna Rosi (UAB)** *In-vitro* diagnostic test based on exosomes for early diagnosis of Alzheimer's disease and risk stratification of patients
PC 22	**Marianna Rossetti (ICN2)** Graphene-based nanomaterials integration with bioreceptors for enhanced point-of-care diagnostics and environmental sensors
PC 23	**Nerea de Mariscal-Molina (ICN2)** Point-of-care haemoglobin detection for anaemia diagnosis
PC 24	**Davi de Farias (ICN2, USP)** Aptamer-based Inkjet-printed nanostructured biosensors for real-time environmental monitoring of antibiotics

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ORAL COMMUNICATIONS

Portable PCR and Electrochemical Genosensing for the Rapid Screening Test Development to Detect Neonatal *Streptococcus agalactiae* Infections

A. del Valle[3,4], M. Mesas[3,4], A. Pallarès-Rusiñol[2], M. Martí[3], B. Baró[1], J. Ferrer-Dalmau[2], Q. Bassat[1], M.I. Pividori[3,4,*]

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**Correspondence: isabel.pividori@uab.cat*

Streptococcus agalactiae (Group B Streptococcus, GBS) is the primary cause of neonatal infections, impacting pregnant mothers and, particularly, their offspring. This infection affects 18% of pregnant women globally, rising to 35% in certain regions. It leads to a range of diseases, including maternal infection, stillbirth, and early- and late-onset sepsis in newborns. Additionally, GBS may contribute to preterm delivery and hypoxic-ischemic encephalopathy. In 2020, an estimated 90,000 infant deaths were attributed to GBS, with nearly half occurring in Sub-Saharan Africa. To mitigate these alarming statistics, preventive antibiotics are proactively administered to the mother during delivery upon positive detection of GBS (typically around week 36 of pregnancy). This measure aims to prevent vertical transmission during childbirth and minimize risks to the baby. However, current detection methods rely on culturing techniques, which have long turnaround times and require sophisticated laboratory infrastructure and training. Diagnosing GBS in newborns is even more challenging, as it requires a minimum volume of blood and/or cerebrospinal fluid for successful culture, which can be difficult to obtain from these patients. Moreover, obtaining results can take several days. Given these limitations, this research project focuses on developing a point-of-care rapid screening test using a handheld thermocycler to perform double-tagging endpoint PCR. This involves conventional PCR with a novel thermostable DNA polymerase targeting a GBS-specific gene, screening various bacterial lysis methods, determining methodology specificity, and establishing the limit of detection. Our results demonstrate a simple, specific, and promising system for detecting the presence of GBS in patients. Further work will involve testing different matrices (blood, vaginorectal swabs) to explore the assay's sensitivity. The development of this device holds the potential to improve current protocols for GBS detection, allowing for rapid point-of-care screening both in expectant mothers and at the newborn's side. Such a breakthrough could significantly reduce the global burden of GBS disease, with a particularly positive impact in low-income countries where implementing microbiological cultures is challenging.

References:

Russell, et al. Clin. Infect. Dis. ***2017****, 65, 100-11.*
Proma, et al. Curr. Opin. Pediatr. ***2019****, 35, 223-230.*
Carinelli, et al. Biosens. Bioelectron. ***2018****, 117, 183-190.*
Lermo, et al. Biosens. Bioelectron. ***2007****, 22, 2010-2017.*
Dagnew, et al. Clin. Infect. Dis. ***2012****, 55, 91-102.*

Portable Medical Device Based on Magneto Immunosensor for the Diagnosis of Celiac Disorder

J.C. Porras[1,3], A. Pallarès-Rusiñol[3], K. Alemany López[1], J. Ferrer-Dalmau[3], M.I. Pividori[1,2,3,*]

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Celiac disease (CD) is a chronic autoimmune disorder that affects individuals regardless of gender, age, or ethnicity, primarily arising from gluten intolerance in genetically predisposed individuals [a,b]. Although its prevalence impacts 1-2% of the global population, there has been a noticeable rise in reported cases over recent decades. The disparity between diagnosed and undiagnosed cases varies by country, with ratios ranging from 1 to 2 in Finland to 1 to 10 in the USA, Argentina, and Germany, suggesting a substantial percentage of cases remain undetected [c]. The main contributor to underdiagnosis is the variability of symptoms, which can mimic those of other diseases, ranging from small intestinal inflammation to diarrhea and other digestive disorders [a]. Current diagnostic methods, conducted in specialized laboratories, include serology, genotyping, and histology. Serology is considered the gold standard among these, despite its lower sensitivity, requiring further invasive tests for confirmation [d]. With the increase in cases, there is a critical need for rapid and accurate diagnostics, especially ones that simplify testing for community and primary care settings. To address this challenge, this work focuses on the study of novel biomarkers for CD based on synthetic deamidated-related peptides, enhancing the sensitivity of existing methods and integrating them into a novel magneto immunosensor. Derived from specific amino acid sequences of generic gliadin, these peptides exhibit a promising predictive value for CD detection. Therefore, when immobilized on magnetic particles, they can serve as distinctive biomarkers for the isolation of gliadin antibodies, and the detection can then be accomplished by amperometry using an enzyme-labeled antibody. The deaminated peptides are integrated on a device platform composed by two main components (**Figure 1**): A) Disposable cartridge, including i) the sample holder containing reagents (including magnetic particles modified with peptide and the labeled-antibody which binds specifically the patient antibodies in 15 minutes), and ii) the cartridge containing the microfluidic and the electrode in which the magnetic actuation is performed, while the excess of sample and reagents are removed. B) Digital reader which allows the electrochemical readout in less than one minute. The output of the device is a quantitative response. This test demonstrates significant potential due to its affordability, speed, sensitivity, minimal handling requirements, and suitability for ambulatory CD screening in primary care. The approach consolidates the competitive advantages of existing diagnostic tests, offering point-of-care convenience, rapidity, user-friendliness, quantifiability, and high predictive power.

Keywords: celiac disease, deamidated peptide, magnetic particles.

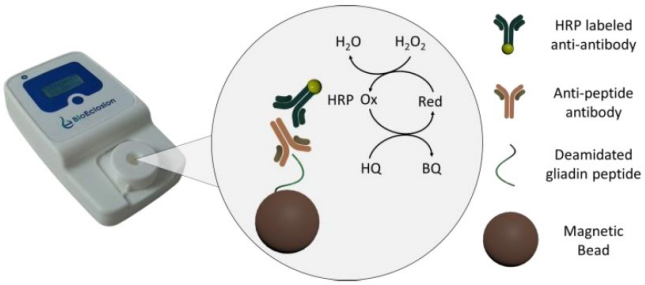

Figure 1. Schematic representation of the magneto electrochemical immunoassay.

References: [a] *Rodrigo, Med.* ***2020****, 56, 8-10.* | [b] *Bai, et al. J. Clin. Gastroenterol.* ***2019****, 53, 313.* | [c] *King, et al. Am. J. Gastroenterol.* ***2020****, 115, 507-525.* | [d] *Charlesworth, Wold J. Gastroenterol.* ***2020****, 26, 1-10.*

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POSTER CONTRIBUTIONS

Integration of Molecularly Imprinted Polymers into Paper-Based Nucleic Acid Lateral Flow Platforms for Enhanced Multiplexed Point-of-Need Diagnostics

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Paper-based immunochromatography tests have become indispensable tools in point-of-need diagnostics, featuring portability, rapidity, and cost-effectiveness. Antibodies are commonly used as biorecognition elements in in vitro diagnostic tests due to their exceptional specificity and ease of chemical modifications. However, their inherent limitations, including susceptibility to chemical and physical denaturation, along with laborious and costly production processes, underscore the need for alternative recognition materials. In response to these challenges, molecularly imprinted polymers (MIPs) have gained considerable attention. MIPs display predetermined recognition sites for target molecules, acting as artificial receptors and offering distinct advantages that address key issues associated with antibodies [a]. Despite their biological counterparts, MIPs can be synthesized through an animal-free, large-scale process at a significantly lower cost. Moreover, their stability enables long-term storage at room temperature without compromising analytical performance.
This work presents, for the first time, the synthesis of MIPs specifically designed for digoxigenin (DIG) and 6-carboxyfluorescein (6-FAM), and their integration as distinct test lines into a multiplexed nucleic acid lateral flow (NALF) platform. Several components and the assay performance were optimized using the simultaneous detection of different double-tagged PCR amplicons from the waterborne pathogen E. coli as a model.
The integration of MIPs as recognition elements proves to be a cost-effective and robust alternative to affinity proteins, showcasing exceptional analytical features. The multiplexed assay demonstrates outstanding sensitivity and specificity, achieving a limit of detection of 0.11 pg and 0.38 pg for MIP-DIG and MIP-6FAM, respectively. This innovative approach not only enables the detection of a wide range of targets but also holds considerable promise for advancing paper-based diagnostic technologies.

Keywords: Molecularly imprinted polymers, multiplexed assay, point-of-need diagnostics, biomimetic receptors.

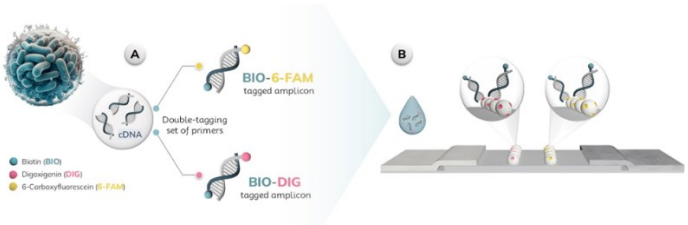

Figure 1. Schematic Representation of Multiplexed NALF: **A)** DNA extraction followed by PCR amplification using two different sets of primers. **B)** Samples are applied to the sample pad and migrate to the nitrocellulose membrane. On the membrane, MIP-DIG and MIP-6FAM selectively interact with the DIG and 6-FAM tags of the amplicons, respectively. Streptavidin-HRP is then added, enabling optical readout by interacting with the BIO-tag of the amplicons. Finally, the visual readout is achieved using TMB, along with the interpretation of the results.

References:
[a] *J. Marfà, et al., Anal. Bioanal. Chem.* ***2021****, 413, 6141-6157.*

Traffic Light-Based Point-of-Care Test for the Rapid Stratification of Fever Syndromes

M. Mesas[3,4], A. del Valle[3,4], M. Martí[4], A. Pallarès-Rusiñol[2], J. Ferrer-Dalmau[2], B. Baró[1], Q. Bassat[1], M.I. Pividori[3,4,*]

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Recent evidence highlights the significance of sTREM-1 and Ang-2 as quantitative novel biomarkers for assessing disease severity, treatment response, and outcomes in various conditions, including malaria, pneumonia, COVID-19, among others fever syndromes. Elevated sTREM-1 levels have shown strong correlations with disease severity, multiple organ dysfunction, and mortality.
To aid in risk stratification, patients in this study were classified into three groups based on their sTREM-1 levels using the WHO-proposed traffic light color system.
A threshold value of 239 pg/mL represented the "green light," indicating low risk, while levels exceeding 629 pg/mL were designated as "red light," signifying an urgent need for admission. An intermediate "yellow light" indicated further monitoring. In this work, we present a rapid test integrating magnetic separation and electrochemical biosensing on a portable device operated by batteries. The laboratory prototype comprises two components: (1) a disposable cartridge containing magnetic particles conjugated with antibodies specific to the biomarker of interest, and (2) a digital reader equipped with an interface for quantitative electrochemical readout. The cartridge's microfluidic system facilitates magnetic actuation, while excess sample and reagents are removed. Within less than one minute, the digital reader provides quantitative readout of the biomarker levels in pg/mL, which is then displayed on the device's screen and transmitted to the accompanying App via Bluetooth.
The device's performance in classifying sTREM-1 levels is presented, demonstrating excellent readout results with a short 15-minute incubation step and a swift 2-minute readout process. This innovative point-of-care test holds great promise for aiding clinicians in rapid risk stratification and timely decision-making, potentially enhancing child survival outcomes and improving patient management in a variety of fever syndromes and specific diseases.

Keywords: Disease severity, point-of-care test, sTREM-1.

In-Vitro Diagnostic Test Based on Exosomes for Early Diagnosis of Alzheimer's Disease and Risk Stratification of Patients

Rosanna Rossi[1,2], Maria Capdevila[3], Amanda Cano[3,4], A. Ruíz[3,4], Mercè Marti[1], Maria Isabel Pividori[1,2,*]

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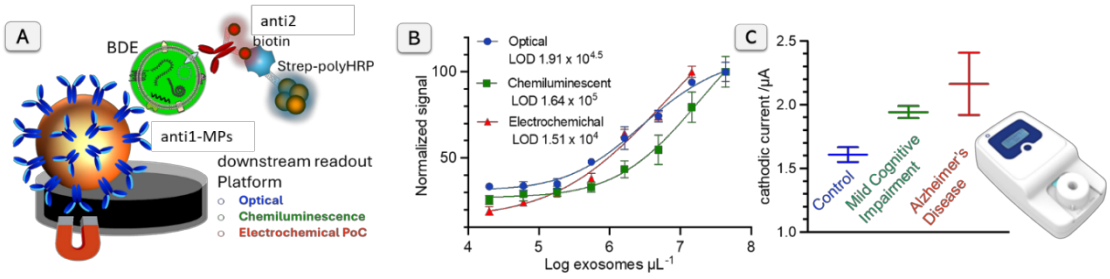
Alzheimer's Disease (AD) is a leading cause of dementia, accounting for 60-70% of cases globally as reported by the World Health Organization (WHO). Diagnosing AD is particularly challenging because by the time symptoms manifest, significant neuronal loss and brain atrophy have already occurred. Current diagnostic methods like brain imaging and cerebrospinal fluid analysis are costly and invasive, leading to low patient compliance. Exosomes, nano-sized extracellular vesicles secreted by most cell types, have been shown to carry AD-related molecules and are promising candidates for early diagnosis biomarkers. Although the full molecular mechanisms of AD are not completely understood, early pathological changes in the brain might be reflected by the amount and characteristics of brain derived exosomes (BDEs). There is evidence that exosomes can pass the brain blood barrier and be found in several body fluids, including blood, representing a huge advantage to the current diagnostic targets. This study aimed to explore the use of BDEs in plasma as biomarkers for AD. We optimized our method using exosomes from the SH-SY5Y neuroblastoma cell line, obtained through differential ultracentrifugation. We used tosyl-activated magnetic nanoparticles functionalized with a specific antibody to capture BDEs (anti1-MPs). Subsequently, we targeted a biomarker specific for AD on the surface of the captured exosomes using a biotinylated antibody (anti2-biotin). We developed immunoassay platforms with optical, chemiluminescent, and electrochemical readouts, as depicted in **Figure 1** (**A**). We got very promising results with the 3 platforms, especially with the electrochemical one, which had a lower LOD (**Figure 1, B**). A screen-printed electrode integrated with electrochemical reader has been used for the analysis of plasma patients with Mild Cognitive Impairment and suspected Alzheimer's Disease. Preliminary results showed the capability of the method for risk stratification of the patients (**Figure 1, C**).

Keywords: Exosomes, in-vitro diagnostic test, biosensors, magnetic particles, Alzheimer's disease.