Abstract for the general public

Sepsis refers to the severe life-threatening body response against infection. Sepsis is an overwhelming inflammation caused commonly by bacteria that affect the human body's immune system which release excessive small protein molecules called cytokines. Once these causes of infection are out of hand leads to low oxygen levels in organs, low blood pressure, and organ dysregulation or dysfunction, thus resulting in septic shock. This process is initially called blood poisoning. Sepsis is one of the major mortality in-hospital all over the worldwide intensive care unit (ICU) patients. Since the patient, admit to the ICU, treatment needs to start within the golden hour of two to three hours. This golden hour, patient whole blood monitoring is highly desirable for patient lifesaving. Sepsis is a healable life-threatening infection upon prior measurable respective biological indicator (biomarker) species or molecules on the body. To reduce the death rates or improve the patient survival rates, prior drugs prescription, onsite selective diagnostic or disease states readers might enhance the patient outcomes. Presently, available diagnosis protocols minimum required clinical results outcome period is 12 to 72 h, and those diagnosis centers are away from the ICUs and medical advisors. In this delayed sepsis, judgment increases the chance of mortality from 6 to 10% per hour. The quality of sepsis sensor device accuracy, sensitivity, and selectivity enhances patient survival management directly. Recently, numerous sepsis-monitoring biomarkers have been investigated in the recent literature, with more than 100 kinds of sepsis biomarkers identified. Understanding the patient's deep insight into health status can be achieved by measuring whole blood samples containing sepsis biomarkers quantification through rapid, accurate, sensitive, and selective sensor probes. The World Health Organization (WHO) report says sepsis biomarker sensing results-based treatment is still a burden for doctors. To measure the sepsis biomarkers quantity from the whole blood, serum, plasma, and cellular fluid, typically applied for clinical sample analysis. Present sensor electrode probe with whole blood sample sensing device lock of accurate results owing to the complex clinical samples containing proteins, cells, biomolecules, and products of electrochemical reactions that were foul on the electrode surface. The unwanted fouling process led to a decrease in the sensor device performance seriously. In addition, the sepsis biomarkers concentrations are often very low as compared to the background current (absence of biomarkers). Therefore, even small changes in background signal noise or degradation or current intensity might lead to false positives, severe method error, and loss of selectivity, eventually, failure results cause patient mortality.

To avoid the above diagnosis error, we aim to produce high conductive MXene to enhance the electrode sensitivity, followed by surface engineering chemistry using organic molecules for the biomarker cross-link attachment. Since MXene is a metallic and ceramic property material that aids excellent conductivity and allows further surface chemistry. MXene modification might minimize the interfering biomatrix fouling issues and raises the signal-to-noise level. We aim to integrate MXene with highly porous electroactive metal-organic framework (MOF) material thin coatings to comprehensively eliminate the fouling issue. MOF can partition the target sepsis biomarker with other sample biomatrix in this project. In addition, MOF linker oxidation-reduction peak current intensity changes will monitor the corresponding biomarker (antigen) concentration in the whole blood sample. Because of the biomarker-specific affinity towards the selector (antibody), the selective biomarker might creep through the pore selectively rather than the other interfering species present in the whole blood sample. The following significant sepsis biomarkers like C-reactive protein, procalcitonin, tumor necrosis factor-alpha, high-mobility group box 1 protein, and interleukin-6 aimed to read using respective selector grafted conductive/porous MOF electrode. The proposed selector-MOF/MXene probe sepsis biomarkers diagnosis results expect to obtain within a few minutes or hours. The innovative functional electrode engineering is expected to deliver high specificity, sensitivity, antifouling activity, and low concentration biomarker determining ability.