GLOBAL BIOMARKER SYSTEM FOR STROKE

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Effective post-stroke care hinges on a holistic, integrated, and personalized approach, starting from improved diagnostics and treatment in clinical settings, to ongoing rehabilitation and community support. To enhance stroke care pathways, efforts are underway to discover biomarkers that could provide valuable insights into the neurological, physiological, and biomechanical effects of stroke, as well as how patients respond to different interventions.In this review paper, we aim to summarize recent research on biomarker discovery, focusing on three main modalities: brain imaging, blood sampling, and gait assessments. We will look at both established and emerging biomarkers, discuss their potential usefulness and complementarity in the context of stroke care, and emphasize the importance of personalized interventions guided by biomarkers to enhance treatment and post-stroke recovery.

Stroke is a complex neurological disorder, and its impact on patients varies depending on a variety of factors. These factors include the severity of the stroke, the area of the brain affected, the brain's ability to adapt (neuroplasticity), treatment options available, timely interventions such as physiotherapy and rehabilitation programs, community support from family and friends, comorbidities, as well as the patient's self-efficacy, motivation, and physical condition. Due to this complexity, it can be difficult to predict long-term outcomes for patients with stroke, and two patients with similarly severe strokes may experience different clinical and functional outcomes. Stroke biomarkers have already started revolutionizing stroke care from diagnosis to clinical outcome prediction and recovery monitoring. Notably, many of these biomarkers come from three modalities: brain imaging, analysis of blood samples and gait measurement. Brain imaging biomarkers are used for early diagnostics, confirming stroke and determining whether it is ischemic or hemorrhagic.They are also useful for prognosis and studying neuroplasticity. Blood biomarkers, although not utilized for diagnostic purposes yet, can be useful for detection of comorbidities and evaluating the risk of post-stroke treatment complications and secondary conditions .Gait and mobility biomarkers, offering valuable information about patients' independence and quality of life, can be used for estimating fall risk, evaluating the effectiveness of rehabilitation programs and detecting undesired behaviors (e.g., prolonged sitting). Here, we aim to provide a comprehensive, up-to-date review of post-stroke brain imaging (mainly focusing on magnetic resonance imaging), blood and gait biomarkers with an emphasis on their complementarity and potential integration for improving stroke care pathways. In this review, we focus on (i) ischemic stroke, (caused by restricted or blocked blood flow) which constitutes 70% of all stroke incidents, and (ii) post-stroke gait and balance disorders which affects almost 80%

of patients. COVID-19 created significant hardships and challenges to clinics and patients in almost every aspect of stroke care from diagnosis to management, and long-term rehabilitation.While there is evidence that COVID-19 might have increased the ischemic stroke risk by 3.6 times,the number of hospital admissions due to ischemic stroke decreased by 15% during the first 3 months of COVID-19. This is thought to be a result of the unwillingness of patients to go to a hospital due to the fear of contracting the virus. Due to extremely time-sensitive nature of ischemic strokes, the value of remote monitoring and telemedicine has become clear to medical professionals. Remote technologies utilizing accessible tools like smartphones can be helpful in monitoring recovery of the patients more effectively and avoiding complications by enabling expert medical attention to patients. Incorporating objective and quantitative biomarkers for remote monitoring systems will introduce immense medical information for medical professionals. Biomarkers obtained from imaging, biochemical and biomechanical measurements combined with clinical assessments can allow for objective and reproducible evaluation and monitoring of the patient. Yet, there is still no established integrative approach to specific biomarkers that is commonly utilized in the clinics.Blood biomarkers can be used for a variety of applications following stroke, including diagnosis and identification of stroke subtypes, predicting clinical outcomes, selecting personalized treatments for patients, and monitoring recovery.

However, as the search for finding a specific blood biomarker continues, it is becoming clearer that a single marker will probably not be adequate in capturing the heterogeneity of stroke and its systemic effects. Hence, integrating various techniques and approaches will be necessary to define a comprehensive and global biomarker system for stroke.