Communication

Emerging Translational Research in Neurological and Psychiatric Diseases: From In Vitro to In Vivo Models

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Editorial

Emerging Translational Research in Neurological and Psychiatric Diseases: From In Vitro to In Vivo Models

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Abastract: Revealing the underlying pathomechanisms of neurological and psychiatric disorders, searching for new biomarkers, and developing novel therapeutics all require translational research. In vivo and in vitro disease models have been instrumental in casting light on complex polygenic, multifactorial, and heterogeneous disease mechanisms. In the most recent years, advanced preclinical models have revealed the intriguing interaction of sex/gender and aging with the pathogenesis and clinical manifestations of psychiatric and neurological diseases. However, despite these advancements, there is still a great deal of work to be done to fully comprehend the underlying mechanisms of these diseases and to develop treatments that can significantly improve the lives of those who suffer from them. The current challenge in the field of neurological and psychiatric diseases is to develop disease-modifying, effective treatments for these complex and long-lasting debilitating conditions with a high burden of disease.The first edition of the research topic 'Emerging Translational Research in Neurological and Psychiatric Diseases: From In Vitro to In Vivo Models' reinforces translational research playing a critical role in bridging the gap between basic research and clinical applications. Also, it provides a platform for researchers to share their findings and advancements in translational research in this field. This new collection gathers 25 papers offering insights into the latest advancements in translational research and potential new avenues for treatments. These papers cover various topics, including the development of new preclinical models, the use of in vitro and in vivo methods, and the application of qualitative and quantitative research methods.

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1. Introduction

Revealing the underlying pathomechanisms of neurological and psychiatric disorders, searching for new biomarkers, and developing novel therapeutics all require translational research [1]. In vivo and in vitro disease models have been instrumental in casting light on complex polygenic, multifactorial, and heterogeneous disease mechanisms [2]. In the most recent years, advanced preclinical models have revealed the intriguing interaction of sex/gender and aging with the pathogenesis and clinical manifestations of psychiatric and neurological diseases [3–5]. However, despite these advancements, there is still a great deal of work to be done to fully comprehend the

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underlying mechanisms of these diseases and to develop treatments that can significantly improve the lives of those who suffer from them. The current challenge in the field of neurological and psychiatric diseases is to develop disease-modifying, effective treatments for these complex and long-lasting debilitating conditions with a high burden of disease.

The first edition of the research topic 'Emerging Translational Research in Neurological and Psychiatric Diseases: From In Vitro to In Vivo Models' reinforces translational research playing a critical role in bridging the gap between basic research and clinical applications. Also, it provides a platform for researchers to share their findings and advancements in translational research in this field. This new collection gathers 25 papers offering insights into the latest advancements in translational research and potential new avenues for treatments. These papers cover various topics, including the development of new preclinical models, the use of in vitro and in vivo methods, and the application of qualitative and quantitative research methods.

2. Topic articles

2.1. Neurological Disorders and Therapies

2.1.1. Pathophysiology

Understanding Alzheimer's disease (AD) mechanisms and developing suitable preclinical models is vital for research [6,7]. Castillo-Mariqueo et al. devise a behavioral observation method to study gait and exploratory activity during AD progression and aging, adding motor symptoms to the classical cognitive view. Their work demonstrates pronounced functional impairment in 3xTg-AD mice, underscoring the model's promise for AD research and therapeutic development [8]. This study contributes to our understanding of AD's complexities and potential treatment avenues, aligning with broader research in this field. Santana-Santana et al. investigate how the marble burying test outcomes differ between male and female mice, shedding light on potential sex-dependent variations in behavior relevant to aging and AD. The article also examines how these behaviors change over time, providing insights into the progression of age- and AD-related behavioral changes in mice [9]. Furthermore, Lam et al. identify age-related disturbances in retinoids and sex hormones, particularly in the context of AD and Parkinson's disease [10]. The research suggests that these molecules might play a pivotal role in the pathogenesis and progression of these debilitating neurological conditions. These insights are valuable for advancing our knowledge of the mechanisms behind AD and Parkinson's disease and potentially paving the way for innovative therapeutic approaches [11,12].

It is essential to develop innovative therapeutic strategies for neurological and cardiovascular diseases, which are leading causes of morbidity and mortality worldwide. Additionally, non-invasive brain stimulation techniques have become an integral part of clinical research in neuropsychiatric disorders [13,14]. Methods such as transcranial magnetic stimulation and transcranial direct current stimulation have been employed in preclinical models to investigate their potential therapeutic effects [15,16]. These techniques offer a unique opportunity to modulate neural activity in specific brain regions, mimicking the neuromodulatory effects observed in human studies [17–19]. Non-invasive brain stimulation in preclinical research allows scientists to explore the neural circuitry involved in neuropsychiatric disorders, providing valuable insights into the underlying mechanisms. It also helps in assessing the safety and efficacy of these techniques before translating them into clinical applications. Mitrečić et al. discuss the potential of stem cell-based therapies, tissue engineering, and regenerative medicine in developing effective treatments for these diseases, emphasizing the importance of interdisciplinary collaboration and the need for a better understanding of the underlying mechanisms of these diseases [20]. Revealing iron metabolism in AD is important due to its significant role in brain function and the development of AD-related pathologies. Peng et al. review the recent progress in the relationship between iron and AD, highlighting the importance of iron in the brain for the treatment of AD and discussing the potential of iron chelators as a therapeutic option for AD [21].

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Three papers have contributed to our knowledge of the pathophysiology of AD and have revealed potential therapeutic targets for the disease. Swingler et al. investigate the role of microRNA-455 in AD-related memory deficits and anxiety, highlighting potential targets for therapeutic intervention [22]. Sheikh et al. discuss the aggregation of cystatin C and its effect on protease activities and the formation of amyloid beta fibrils, which are key pathological mechanisms in AD [23]. In an in vitro model of AD, Fernandes et al. investigate the structural and functional alterations in mitochondria-associated membranes and mitochondria, shedding light on the stress response mechanisms activated by the disease [24]. These papers collectively provide valuable information about the underlying mechanisms of AD and potential therapeutic targets, which can aid in the development of new treatments for the disease.

2.1.2. Therapies

Researchers investigate the therapeutic potential of mesenchymal stem cells (MSCs) for neurological disorders. Fu et al. demonstrate that xenografts of human umbilical MSCs promote recovery from chronic ischemic stroke in rats [25]. The article highlights the potential of MSCs in treating chronic stroke and provides insights into the therapeutic benefits of xenotransplantation of MSCs. Kassab et al. discuss a systems biology perspective on the role of systemic filtering organs, particularly the kidney, in aging and rejuvenation. It provides an overview of the major systemic causes of aging and identifies the filtration system as a clear gap in aging studies to date. The paper concludes by exploring possible future rejuvenation avenues that need to be developed to address the complex topic of healthy aging [26]. These papers provide valuable information about the therapeutic potential of MSCs in the treatment of neurological disorders and regenerative medicine, which can aid in the development of novel therapeutic strategies for these diseases.

The common mechanisms of neurodegeneration, such as inflammation, amyloid pathology, and microglial dysfunction, are explored in three articles that focus on AD and Parkinson's disease, two prevalent neurodegenerative diseases [27]. The articles also propose novel treatments that target these mechanisms. One article by Hsu et al. evaluates the effect of peiminine on Parkinson's disease by regulating the PINK1/Parkin pathway [28]. Another article by Tsay et al. assesses the effect of EK100 and Antrodin C on AD by enhancing microglial and perivascular clearance pathways [29]. A third article by Kuo et al. examines the role of neuron-microglia contacts in controlling PGE2 tolerance and the effect of inhibiting TLR4-mediated de novo protein synthesis on neurodegeneration [30]. Bezerra et al. also investigate the possible role of SerpinA1 in modulating transthyretin proteolysis, a process involved in various neurodegenerative disorders, including AD and familial amyloid polyneuropathy [31]. These papers offer valuable insights into the potential of new therapeutic strategies for neurodegenerative diseases, which can facilitate the development of effective treatments for these diseases.

Bellon et al. investigate the optimization of neurite tracing and further characterization of neuronal-like cells derived from human monocytes [32]. Revealing the mechanisms underlying the differentiation of human circulating monocytes into neuronal-like cells is crucial for the development of novel therapeutic strategies for neurological disorders, as demonstrated by this study. The findings contribute to the growing body of research on the potential for transdifferentiation of circulating monocytes in human blood into neuronal-like cells, which could lead to improved outcomes for patients with neurological disorders.

Transcranial alternating current stimulation has the potential to reduce the symptoms of AD and improve cognitive function in those who have it. Jeong et al. examined the effects of tACS on long-term potentiation in transgenic mice with AD, which is an important process for learning and memory. The advantage of using tACS in this experiment is that its current can oscillate at a specific frequency and interact with the intrinsic oscillation of the brain [33]. The article highlights the potential of tACS in treating AD-related cognitive impairments, which can aid in the development of novel therapeutic strategies for AD.

Chen et al. investigate the potential role of microRNA-124 in treating retinal vasoregression in neurodegenerative diseases [34]. The study highlights the significance of microRNA-124 in

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regulating microglial polarization, which is implicated in the retinal vasoregression of neurodegenerative diseases. The findings contribute to the understanding of the potential of microRNA-124 in treating retinal vasoregression in neurodegenerative diseases, aiding in the development of novel therapeutic strategies for these diseases. The article also sheds light on the potential of microglial polarization as a therapeutic target for neurodegenerative diseases.

In a preclinical model of multiple sclerosis (MS), Quirant-Sánchez et al. investigate the use of a combined therapy approach involving vitamin D3-tolerogenic dendritic cells and interferon-β. The findings suggest that in a preclinical model, this combined therapy can effectively reduce the severity of MS symptoms and improve overall outcomes, potentially leading to the development of novel MS therapeutic strategies [35]. Thus, it is evident that the use of preclinical models has been instrumental in propelling research on MS forward [36]. These investigtions have not only deepened our understanding of the intricate mechanisms underlying the disease but have also been key in identifying potential biomarkers [37,38]. Furthermore, they have opened new avenues for the discovery of innovative treatments. Thus, the importance of these studies in shaping the future of MS research is undeniable.

2.2. Pain

Pain and mental illnesses are inextricably linked, and their comorbidities have been extensively researched [39–41]. Neurogenic inflammation and neuropeptides have been implicated in the pathophysiology of various human diseases, including primary headache disorders and peripheral neuropathy [42]. These articles investigate the potential function of neurogenic inflammation and neuropeptides in the etiology and progression of a wide range of human diseases, from primary headache disorders to peripheral neuropathy [43]. The article by Spekker et al. discusses the impact of neurogenic inflammation on migraines and reviews recent findings from translational research on the subject [44]. A better understanding of its role in migraine could have important implications for the clinical management of this neurological disorder. Using the Class I HDAC inhibitor MS-275, Lamoine et al. provide important new information about the benefits of using this drug to prevent chronic neuropathy and improve antiproliferative activity in mice. The study utilizes a systems biology approach, combining transcriptomic and bioinformatic analyses to identify the molecular mechanisms underlying the effects of MS-275 [45]. The article highlights the potential of systems biology approaches in identifying novel therapeutic targets and developing more effective treatments for various diseases.

2.3. Psychiatric disorders, pathophysiology, biomarkers, therapies

Five articles highlight the significance of revealing the mechanisms underlying various diseases and conditions, including, autism, sleep disturbance, and metabolic dysfunction in developing novel therapeutic strategies. The role of the cerebellum and striatum in autism spectrum disorders is investigated by Thabault et al. This study is valuable because it investigates the neurological aspects of autism spectrum disorder, sheds light on potential mechanisms, and provides a link between clinical observations and preclinical models [46]. Lee et al. investigate the influence of maternal immune activation on male rat offspring. Maternal immune activation was associated with social behavior deficits and hypomyelination, a condition characterized by reduced myelin in the brain, according to the research. These effects were observed in male rat offspring, and the investigation suggests that they have an autism-like microbiota profile [47]. Abuaish et al. investigate the potential of fecal transplant and Bifidobacterium treatments in modulating gut Clostridium bacteria and rescuing social impairment and hippocampal brain-derived neurotrophic factor expression in a rodent model of autism [48]. The article highlights the significance of understanding the role of gut microbiota dysbiosis in the pathophysiology of autism and the potential of microbiota-based interventions in developing novel therapeutic strategies for autism.

Sleep is an integral component of energy metabolism, and sleep disturbance has been implicated in a wide range of metabolic disorders. Wei et al. provide a balanced overview of adipokines and their roles in sleep physiology and sleep disorders from recent human and preclinical studies [49].

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The significance of this review lies in its contribution to the understanding of the relationship between sleep disturbance, metabolic dysfunction, and adipokines, which can aid in the development of novel therapeutic strategies for metabolic disorders. Garro-Martínez et al. investigate the potential role of mTOR expression in the infralimbic cortex in the pathophysiology of depression [50]. The article highlights the significance of revealing the mechanisms underlying mTOR expression in the infralimbic cortex and its potential role in the development of depressive-like behaviors. The findings contribute to the growing body of research on the potential of mTOR as a therapeutic target for depression, potentially leading to improved outcomes for individuals with this condition.

3. Conclusion and future directions

In vitro- and in vivo-based preclinical research serves as a vital complement to human studies in understanding neuropsychiatric disorders [51–55]. These models allow researchers to simulate disease conditions, exploring the intricate connections between genetics, environment, pharmacology, and comorbidities [56–60]. This research provides insights into the mechanisms underlying mental and neurological disorders, facilitates the testing of potential treatments, and evaluates therapeutic efficacy [61]. For instance, studies in translational research illustrate how preclinical models aid in translating findings from the lab to clinical applications. Preclinical models have also been crucial in exploring neurological and psychiatric conditions like AD and autism spectrum disorder and shedding light on their underlying factors. Furthermore, this approach contributes to the development of personalized medicine by allowing tailored treatments for mental disorders. It also enables the investigation of structural changes in the brain and the development of advanced imaging techniques for clinical use. Preclinical research plays an essential role in unraveling the complexities of brain illnesses, offering valuable insights, testing treatments, and paving the way for innovative therapeutics and personalized medicine.

In this multidisciplinary endeavor, neuropharmacological research plays a pivotal role. The study of how drugs and compounds interact with the intricate neural networks in preclinical models provides a deeper understanding of potential therapeutic agents [62–69]. These insights guide the development of pharmacological interventions that can target specific molecular pathways implicated in neuropsychiatric disorders. Researchers are exploring novel drug candidates, investigating their safety profiles, and assessing their efficacy in mitigating the symptoms of conditions like depression, anxiety, and cognitive impairments associated with neuropsychiatric disorders [70]. Advanced imaging techniques have significantly aided research on neuropsychiatric disorders. According to neuroimaging research, the disorders are associated with changes in brain structure and function [71–78]. These imaging methods can aid in the diagnosis of rare clinical cases and shed light on the underlying pathophysiology of the disorders being studied. Furthermore, neuropharmacological research dovetails with the broader scope of preclinical investigations, allowing for a comprehensive exploration of the genetic, environmental, and pharmacological factors influencing mental health [66, 68]. It facilitates the identification of potential drug targets and the development of personalized medicine approaches tailored to individuals' unique neurochemical profiles [79–81].

In summary, we aspire for this subject to act as a pivotal platform for the exploration of the neural foundations of psychiatric and neurological disorders. Researchers are attempting to open fresh paths for specialized treatment plans and preventive measures with the ultimate goal of improving the quality of life for those suffering from these complex mental health conditions by examining behavioral neuroscience from this perspective [82–88]. As our comprehension of the mechanisms underlying neuropsychiatry advances, we draw nearer to a future where individuals can receive personalized care and support to conquer these challenging disorders.

This comprehensive and interdisciplinary approach is echoed in various academic works and research endeavors, which serves as a valuable resource in comprehending the etiological factors, searching for biomarkers, achieving precision, and mastering personalized treatment for neuropsychiatric disorders. Additionally, discussions about the quest for neuropsychiatric biomarkers and endophenotypes are ongoing in academia [89]. Philosophical perspectives on

neuropsychiatric topics are also investigated, thereby contributing to the philosophical comprehension of psychology [90]. Research in this area often involves the examination of abstracts and articles, as exemplified by the National Institutes of Health's database. This collective effort and interdisciplinary collaboration underscore the importance of advancing our understanding of neuropsychiatric disorders and working towards improved treatments and support for affected individuals. We wish to express our heartfelt appreciation to all the contributors to this collection and extend our gratitude to the reviewers for their invaluable feedback. We eagerly await future contributions that will further propel the fields of neurology and psychiatry, recognizing that your unwavering support and dedication play an indispensable role in shaping the progress and potential of this rapidly expanding domain.

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Abbreviations

AD	Alzheimer's disease
MS	multiple sclerosis
MSCs	mesenchymal stem cells

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