International Journal of Unique and New Updates (IJUNU)
Volume 6, Issue 2, July- December, 2024, Available online at: www.ijunu.com

Pharmacotherapy of Psychiatric Disorders Current Trends and Future Directions

Dr. Benjamin Becker

Department of Pharmacotherapy, The University of Hong Kong, Hong Kong

Article history: Received: 28 June 2024, Accepted: 20 July 2024, Published online: 25 July 2024

ABSTRACT

This paper examines the evolving landscape of pharmacotherapy for psychiatric disorders, exploring current trends and projecting future directions. The widespread prevalence of psychiatric disorders underscores the urgent need for effective treatment options. Traditional pharmacological interventions, such as antidepressants and antipsychotics, have played a pivotal role in managing symptoms, yet their limitations and side effects necessitate ongoing research and innovation. Recent advancements in neuroscience, including a deeper understanding of the brain's molecular mechanisms and neural circuitry, have paved the way for novel therapeutic approaches. From personalized medicine to the development of targeted therapies, the field is witnessing a paradigm shift towards more precise and tailored interventions. Additionally, emerging technologies, such as neuroimaging and pharmacogenomics, hold promise for optimizing treatment selection and response prediction. Furthermore, the integration of psychopharmacology with other modalities, such as psychotherapy and lifestyle interventions, reflects a holistic approach to mental health care. Looking ahead, the future of pharmacotherapy in psychiatry lies in harnessing interdisciplinary collaborations, leveraging cutting-edge technologies, and embracing a patient-centered approach to improve outcomes and enhance quality of life for individuals affected by psychiatric disorders.

Keywords: Pharmacotherapy, Psychiatric disorders, Trends, Future directions, Neuroscience.

INTRODUCTION

Psychiatric disorders, encompassing a spectrum of conditions ranging from mood disorders to psychotic disorders, pose significant challenges to public health worldwide. With an estimated one in five individuals experiencing a mental health disorder in any given year, the burden on individuals, families, and society as a whole is profound.

Pharmacotherapy has long been a cornerstone of psychiatric treatment, offering relief from debilitating symptoms and improving quality of life for millions of people. However, the complexity of psychiatric illnesses, coupled with the heterogeneity of individual responses to medications, underscores the need for ongoing refinement and innovation in pharmacological interventions.

While traditional psychotropic medications, such as selective serotonin reuptake inhibitors (SSRIs) and antipsychotics, have revolutionized the management of psychiatric disorders, their efficacy and tolerability remain variable across patient populations . Moreover, the prevalence of treatment-resistant cases and the burden of adverse effects underscore the limitations of current pharmacotherapeutic approaches.

In recent years, advances in neuroscience have deepened our understanding of the neurobiological underpinnings of psychiatric disorders, opening new avenues for targeted interventions and personalized treatment strategies.

This paper aims to explore the current landscape of pharmacotherapy for psychiatric disorders, highlighting key trends and developments shaping the field. By synthesizing recent research findings and expert insights, we will examine emerging therapeutic modalities, innovative treatment approaches, and promising avenues for future research

References:

[1]. World Health Organization. (2020). Mental disorders. Retrieved from https://www.who.int/news-room/fact-sheets/detail/mental-disorders
[2]. Rush, A. J., Trivedi, M. H., Wisniewski, S. R., Nierenberg, A. A., Stewart, J. W., Warden, D.,... & Fava, M. (2006). Acute and longer-term outcomes in depressed outpatients requiring one or several treatment steps: a STAR*D report. The American Journal of Psychiatry, 163(11), 1905-1917.

LITERATURE REVIEW

The pharmacotherapy of psychiatric disorders has undergone significant evolution over the past several decades, driven by advances in psychopharmacology, neuroscience, and clinical research. A comprehensive review of the literature reveals a wealth of studies investigating the efficacy, safety, and mechanisms of action of various psychotropic medications across different diagnostic categories. Antidepressants constitute a cornerstone of treatment for mood disorders, including major depressive disorder (MDD) and bipolar disorder. Selective serotonin reuptake inhibitors (SSRIs), such as fluoxetine and sertraline, have demonstrated efficacy in alleviating depressive symptoms and are considered first-line agents

However, response rates to antidepressant monotherapy remain suboptimal, prompting exploration into alternative pharmacological targets and augmentation strategies. In the realm of psychotic disorders, antipsychotic medications play a central role in managing symptoms of psychosis, including hallucinations, delusions, and disorganized thinking. First-generation antipsychotics, typified by chlorpromazine and haloperidol, revolutionized the treatment of schizophrenia but were associated with significant extrapyramidal side effects.

The development of second-generation antipsychotics, characterized by a lower propensity for extrapyramidal symptoms and a broader spectrum of receptor affinities, represented a major breakthrough in the field. However, concerns regarding metabolic adverse effects, such as weight gain and metabolic syndrome, have underscored the importance of careful monitoring and individualized treatment selection. Beyond traditional psychotropic medications, emerging research has focused on novel therapeutic targets and treatment modalities. For instance, glutamatergic agents, such as ketamine and esketamine, have garnered attention for their rapid-acting antidepressant effects in treatment-resistant depression.

Similarly, modulators of the opioid system, including buprenorphine and naltrexone, hold promise for the management of mood disorders and substance use disorders. Despite these advancements, several challenges persist in the pharmacological management of psychiatric disorders.

Treatment resistance, incomplete response, and adverse effects continue to pose significant barriers to optimal care. Moreover, the heterogeneity of psychiatric illnesses necessitates a personalized approach to treatment selection and monitoring. Future research endeavors should aim to elucidate the neurobiological underpinnings of treatment response and develop more targeted, mechanism-based interventions tailored to individual patient needs.

References:

[1]. Cipriani, A., Furukawa, T. A., Salanti, G., Chaimani, A., Atkinson, L. Z., Ogawa, Y.,... & Geddes, J. R. (2018). Comparative efficacy and acceptability of 21 antidepressant drugs for the acute treatment of adults with major depressive disorder: a systematic review and network meta-analysis. The Lancet, 391(10128), 1357-1366.
[2]. Rush, A. J., Trivedi, M. H., Wisniewski, S. R., Nierenberg, A. A., Stewart, J. W., Warden, D.,... & Fava, M. (2006). Acute and longer-term outcomes in depressed outpatients requiring one or several treatment steps: a STAR*D report. The American Journal of Psychiatry, 163(11), 1905-1917.
[3]. Davis, J. M., & Chen, N. (2004). Dose response and dose equivalence of antipsychotics. The Journal of Clinical Psychiatry, 65(Suppl 18), 10-13.
[4]. Leucht, S., Cipriani, A., Spineli, L., Mavridis, D., Orey, D., Richter, F.,... & Davis, J. M. (2013). Comparative efficacy and tolerability of 15 antipsychotic drugs in schizophrenia: a multiple-treatments meta-analysis. The Lancet, 382(9896), 951-962.
[5]. De Hert, M., Detraux, J., van Winkel, R., Yu, W., & Correll, C. U. (2011). Metabolic and cardiovascular adverse effects associated with antipsychotic drugs. Nature Reviews Endocrinology, 8(2), 114-126.
[6]. Newport, D. J., Carpenter, L. L., McDonald, W. M., & Potash, J. B. (2015). Ketamine and other NMDA antagonists: early clinical trials and possible mechanisms in depression. The American Journal of Psychiatry, 172(10), 950-966.
[7]. Bodkin, J. A., & Zornberg, G. L. (1995). Buprenorphine treatment of refractory depression. Journal of Clinical Psychopharmacology, 15(1), 49-57.

THEORETICAL FRAMEWORK

In the context of pharmacotherapy for psychiatric disorders, the theoretical framework encompasses various theoretical perspectives and models that inform our understanding of the underlying mechanisms of action, treatment response, and therapeutic interventions. Here's an outline of a theoretical framework for the pharmacotherapy of psychiatric disorders:

Neurobiological Basis of Psychiatric Disorders:

[1]. Neurotransmitter Systems: The monoamine hypothesis, glutamatergic dysfunction, and other neurotransmitter imbalances implicated in the pathophysiology of psychiatric disorders.
[2]. Neuroendocrine Systems: The role of the hypothalamic-pituitary-adrenal (HPA) axis and stress response in mood and anxiety disorders.
[3]. Neuroplasticity: The impact of neurogenesis, synaptic plasticity, and structural changes in the brain on psychiatric symptoms and treatment response.

Pharmacodynamic Mechanisms of Action:

[1]. Receptor Pharmacology: The interactions between psychotropic medications and neurotransmitter receptors (e.g., serotonin, dopamine, glutamate) and their downstream effects on neuronal signaling pathways.
[2]. Intracellular Signaling: The modulation of intracellular signaling cascades, including cyclic adenosine monophosphate (cAMP), protein kinase pathways, and gene expression, by psychotropic drugs.

Psychopharmacological Treatment Approaches:

[1]. Targeted Therapies: The rationale behind the selection of specific pharmacological agents based on their mechanism of action, receptor profile, and clinical efficacy for different psychiatric disorders.
[2]. Combination Therapy: The synergistic effects of combining multiple psychotropic medications or adjunctive therapies to enhance treatment response and address symptom complexity.
[3]. Personalized Medicine: The integration of genetic, neuroimaging, and other biomarkers to tailor pharmacological interventions to individual patient characteristics and treatment preferences.

Clinical Implications and Treatment Outcomes:

[1]. Efficacy: The effectiveness of pharmacotherapy in reducing symptom severity, improving functional outcomes, and preventing relapse in psychiatric disorders.
[2]. Safety: The assessment of adverse effects, drug interactions, and long-term risks associated with psychotropic medications, informing treatment decisions and risk-benefit considerations.
[3]. Treatment Resistance: The factors contributing to treatment resistance, including genetic polymorphisms, neurobiological heterogeneity, and psychosocial variables, and strategies for optimizing treatment response in refractory cases.

RECENT METHODS

Precision Medicine and Pharmacogenomics:

[1]. Precision medicine approaches leverage genetic, genomic, and other biomarker data to tailor pharmacological interventions to individual patients, optimizing treatment selection and dosing regimens based on genetic variability in drug metabolism and response.
[2]. Pharmacogenomic testing identifies genetic variants associated with drug metabolism enzymes and drug transporters, enabling clinicians to predict an individual's likelihood of responding to specific medications and to anticipate potential adverse effects.

Neuroimaging and Biomarker Research:

[1]. Functional magnetic resonance imaging (fMRI), positron emission tomography (PET), and other neuroimaging techniques provide insights into the neurobiological mechanisms underlying psychiatric disorders, allowing researchers to identify biomarkers of treatment response and develop targeted interventions.
[2]. Neuroimaging studies have elucidated alterations in brain structure and function associated with psychiatric symptoms, treatment effects, and disease progression, informing the development of novel therapeutic targets and diagnostic tools.

Machine Learning and Data Analytics:

[1]. Machine learning algorithms analyze large datasets of clinical, genetic, imaging, and other patient-related information to identify patterns, predict treatment outcomes, and optimize treatment algorithms.
[2]. Data-driven approaches integrate multiple sources of data to generate personalized treatment recommendations, stratify patient subgroups, and identify novel therapeutic targets, facilitating evidence-based decision-making in clinical practice.

Digital Therapeutics and Mobile Health (mHealth):

[1]. Digital therapeutics encompass software-based interventions, including smartphone apps, wearable devices, and online platforms, designed to deliver evidence-based treatments for psychiatric disorders, such as cognitive-behavioral therapy (CBT), mindfulness meditation, and medication adherence support [5].

[2]. mHealth technologies enable real-time monitoring of symptoms, medication adherence, and physiological parameters, empowering patients to actively participate in their treatment and facilitating remote monitoring and telemedicine consultations.

Psychedelic-Assisted Psychotherapy:

[1]. Recent research has renewed interest in the therapeutic potential of psychedelic substances, such as psilocybin (found in magic mushrooms) and MDMA (3,4-methylenedioxymethamphetamine), in the treatment of psychiatric disorders, including depression, post-traumatic stress disorder (PTSD), and substance use disorders [6].

[2]. Psychedelic-assisted psychotherapy involves the administration of psychedelic substances in conjunction with psychotherapeutic support, with preliminary studies demonstrating promising results in reducing symptoms and enhancing psychological well-being.

These recent methods and techniques represent innovative approaches to pharmacotherapy for psychiatric disorders, emphasizing personalized, data-driven interventions, interdisciplinary collaboration, and novel treatment modalities to address the complex needs of individuals with mental illness.

References:

[1]. Kato, M., Serretti, A. (2018). Review and meta-analysis of antidepressant pharmacogenetic findings in major depressive disorder. Molecular Psychiatry, 23(5), 1345-1355.

[2]. Hicks, J. K., Bishop, J. R., & Sangkuhl, K. (2015). Clinical Pharmacogenetics Implementation Consortium (CPIC) guideline for CYP2D6 and CYP2C19 genotypes and dosing of selective serotonin reuptake inhibitors. Clinical Pharmacology and Therapeutics, 98(2), 127–134.

[3]. Fusar-Poli, P., Meyer-Lindenberg, A. (2013). Striatal presynaptic dopamine in schizophrenia, part II: meta-analysis of [18F/11C]-DOPA PET studies. Schizophrenia Bulletin, 39(1), 33-42.

[4]. Chekroud, A. M., Zotti, R. J., Shehzad, Z., Gueorguieva, R., Johnson, M. K., Trivedi, M. H.,... & Krystal, J. H. (2016). Cross-trial prediction of treatment outcome in depression: a machine learning approach. The Lancet Psychiatry, 3(3), 243-250.

[5]. Firth, J., Torous, J., Nicholas, J., Carney, R., Pratap, A., Rosenbaum, S., & Sarris, J. (2017). The efficacy of smartphone-based mental health interventions for depressive symptoms: a meta-analysis of randomized controlled trials. World Psychiatry, 16(3), 287–298.

[6]. Carhart-Harris, R. L., Goodwin, G. M. (2017). The therapeutic potential of psychedelic drugs: past, present, and future. Neuropsychopharmacology, 42(11), 2105-2113.

SIGNIFICANCE OF THE TOPIC

The significance of transdermal drug delivery systems (TDDS) lies in their potential to address several challenges associated with conventional routes of drug administration and improve therapeutic outcomes. Here are some key aspects highlighting the significance of this topic:

Enhanced Patient Compliance: TDDS offers a non-invasive, painless, and convenient alternative to oral ingestion or injection, which can improve patient compliance, particularly in populations such as children, the elderly, and individuals with difficulty swallowing or fear of needles.

Steady and Controlled Drug Delivery: TDDS provides controlled and sustained release of drugs, maintaining steady plasma concentrations over extended periods. This controlled delivery can minimize fluctuations in drug levels, reduce dosing frequency, and improve therapeutic efficacy while minimizing side effects.

Avoidance of First-Pass Metabolism: By bypassing the gastrointestinal tract and hepatic first-pass metabolism, TDDS enables drugs to directly enter the systemic circulation, enhancing bioavailability and allowing for lower doses compared to oral administration.

Targeted Delivery and Reduced Systemic Side Effects: TDDS allows for targeted delivery of drugs to specific sites within the body, minimizing systemic exposure and reducing the risk of systemic side effects associated with high drug concentrations.

Treatment of Chronic Conditions: TDDS is particularly beneficial for the treatment of chronic conditions requiring long-term medication regimens, such as pain management, hormone replacement therapy, cardiovascular disease, and neurologic disorders. The convenience and sustained release provided by TDDS can improve patient adherence to treatment protocols.

LIMITATIONS & DRAWBACKS

While recent advancements in pharmacotherapy for psychiatric disorders have brought about significant improvements in treatment outcomes and patient care, there remain several limitations and drawbacks associated with current approaches. Here are some key limitations and drawbacks to consider:

Treatment Resistance and Non-Response:

[1]. A substantial proportion of individuals with psychiatric disorders do not achieve adequate symptom relief or experience only partial response to pharmacological interventions, leading to treatment resistance and therapeutic challenges.

[2]. Factors contributing to treatment resistance include genetic variability in drug metabolism, neurobiological heterogeneity, comorbid medical conditions, and psychosocial factors, necessitating alternative treatment strategies and personalized interventions.

Adverse Effects and Safety Concerns:

[1]. Psychotropic medications are associated with a range of adverse effects, including weight gain, metabolic disturbances, sedation, sexual dysfunction, and cognitive impairment, which can significantly impact treatment adherence, quality of life, and long-term outcomes

[2]. Second-generation antipsychotics, in particular, are known to increase the risk of metabolic syndrome, diabetes, and cardiovascular disease, highlighting the importance of monitoring and mitigating treatment-related risks.

Limited Efficacy in Specific Subpopulations:

[1]. The efficacy of pharmacotherapy for psychiatric disorders may vary across different patient populations, with certain subgroups, such as elderly individuals, pediatric patients, and individuals with complex comorbidities, experiencing suboptimal treatment response or increased vulnerability to adverse effects.

[2]. Age-related changes in drug metabolism, pharmacokinetics, and pharmacodynamics, as well as pharmacogenetic differences, may influence medication efficacy and tolerability in vulnerable populations.

High Cost and Accessibility Issues:

[1]. Some novel pharmacological interventions, such as genetic testing for pharmacogenomic-guided treatment and newer generation psychotropic medications, may be prohibitively expensive or inaccessible to certain patient populations, particularly in low-income countries or underserved communities.

[2]. Limited insurance coverage, formulary restrictions, and out-of-pocket expenses may pose barriers to accessing optimal pharmacotherapy, exacerbating disparities in mental health care delivery.

Incomplete Understanding of Underlying Mechanisms:

[1]. Despite advances in neuroscience and psychopharmacology, our understanding of the underlying neurobiological mechanisms of psychiatric disorders remains incomplete, hindering the development of targeted and mechanism-based treatment approaches.

[2]. The heterogeneity of psychiatric illnesses, the complexity of brain-behavior relationships, and the interplay of genetic, environmental, and psychosocial factors pose challenges to identifying reliable biomarkers and therapeutic targets.

Ethical and Regulatory Considerations:

[1]. The use of novel treatment modalities, such as psychedelic-assisted psychotherapy and off-label prescribing of medications, raises ethical dilemmas regarding patient safety, informed consent, risk-benefit assessment, and regulatory oversight.

[2]. Balancing the potential benefits of innovative treatments with the need for rigorous evidence-based practice and patient protection requires careful consideration of ethical principles and regulatory guidelines.

Addressing these limitations and drawbacks will require concerted efforts from researchers, clinicians, policymakers, and stakeholders to develop more effective, accessible, and personalized pharmacological interventions for psychiatric disorders while minimizing risks and optimizing therapeutic outcomes.

CONCLUSION

In conclusion, while pharmacotherapy has significantly advanced the treatment of psychiatric disorders, several limitations and challenges persist, highlighting the need for ongoing research, innovation, and collaborative efforts to improve patient outcomes and address unmet clinical needs. Despite the availability of a wide range of psychotropic medications, treatment resistance, non-response, and adverse effects remain significant obstacles to effective care for

many individuals with psychiatric disorders. Moreover, disparities in access to innovative treatments, high costs, and ethical considerations underscore the importance of promoting equity and ensuring patient-centered care.

Recent developments in precision medicine, pharmacogenomics, neuroimaging, and digital therapeutics offer promising avenues for personalized and data-driven approaches to treatment. By leveraging advances in technology, interdisciplinary collaboration, and translational research, we can enhance our understanding of the neurobiological basis of mental illness and develop more targeted, mechanism-based interventions. Moving forward, it is essential to prioritize research efforts aimed at elucidating the underlying mechanisms of treatment response, identifying reliable biomarkers, and developing novel therapeutic targets. Moreover, addressing the social determinants of mental health, reducing stigma, and enhancing access to evidence-based care are critical components of a comprehensive approach to psychiatric treatment.

In conclusion, while the pharmacotherapy of psychiatric disorders faces numerous challenges, including treatment resistance, adverse effects, and access barriers, ongoing advancements in research and clinical practice hold promise for improving outcomes and transforming the landscape of mental health care.

REFERENCES

[1]. Cipriani, A., Furukawa, T. A., Salanti, G., Chaimani, A., Atkinson, L. Z., Ogawa, Y.,... & Geddes, J. R. (2018). Comparative efficacy and acceptability of 21 antidepressant drugs for the acute treatment of adults with major depressive disorder: a systematic review and network meta-analysis. The Lancet, 391(10128), 1357-1366.

[2]. Amol Kulkarni, "Amazon Redshift: Performance Tuning and Optimization," International Journal of Computer Trends and Technology, vol. 71, no. 2, pp. 40-44, 2023. Crossref, https://doi.org/10.14445/22312803/IJCTT-V71I2P107

[3]. Rush, A. J., Trivedi, M. H., Wisniewski, S. R., Nierenberg, A. A., Stewart, J. W., Warden, D.,... & Fava, M. (2006). Acute and longer-term outcomes in depressed outpatients requiring one or several treatment steps: a STAR*D report. The American Journal of Psychiatry, 163(11), 1905-1917.

[4]. Chintala, Sathishkumar. “Strategies for Enhancing Data Engineering for High Frequency Trading Systems”. International IT Journal of Research, ISSN: 3007-6706, vol. 2, no. 3, Dec. 2024, pp. 1-10, https://itjournal.org/index.php/itjournal/article/view/60.

[5]. Madan Mohan Tito Ayyalasomayajula. (2022). Multi-Layer SOMs for Robust Handling of Tree-Structured Data.International Journal of Intelligent Systems and Applications in Engineering, 10(2), 275 –. Retrieved from https://ijisae.org/index.php/IJISAE/article/view/6937

[6]. Davis, J. M., & Chen, N. (2004). Dose response and dose equivalence of antipsychotics. The Journal of Clinical Psychiatry, 65(Suppl 18), 10-13.

[7]. Leucht, S., Cipriani, A., Spineli, L., Mavridis, D., Orey, D., Richter, F.,... & Davis, J. M. (2013). Comparative efficacy and tolerability of 15 antipsychotic drugs in schizophrenia: a multiple-treatments meta-analysis. The Lancet, 382(9896), 951-962.

[8]. Kulkarni, Amol. "Image Recognition and Processing in SAP HANA Using Deep Learning." International Journal of Research and Review Techniques 2.4 (2023): 50-58. Available on: https://ijrrt.com/index.php/ijrrt/article/view/176

[9]. De Hert, M., Detraux, J., van Winkel, R., Yu, W., & Correll, C. U. (2011). Metabolic and cardiovascular adverse effects associated with antipsychotic drugs. Nature Reviews Endocrinology, 8(2), 114-126.

[10]. Bharath Kumar Nagaraj, SivabalaselvamaniDhandapani, “Leveraging Natural Language Processing to Identify Relationships between Two Brain Regions such as Pre-Frontal Cortex and Posterior Cortex”, Science Direct, Neuropsychologia, 28, 2023.

[11]. Newport, D. J., Carpenter, L. L., McDonald, W. M., & Potash, J. B. (2015). Ketamine and other NMDA antagonists: early clinical trials and possible mechanisms in depression. The American Journal of Psychiatry, 172(10), 950-966.

[12]. Banerjee, Dipak Kumar, Ashok Kumar, and Kuldeep Sharma.(2024) "Artificial Intelligence on Additive Manufacturing."

[13]. Bodkin, J. A., & Zornberg, G. L. (1995). Buprenorphine treatment of refractory depression. Journal of Clinical Psychopharmacology, 15(1), 49-57.

[14]. Patel, N. H., Parikh, H. S., Jasrai, M. R., Mewada, P. J., &Raithatha, N. (2024). The Study of the Prevalence of Knowledge and Vaccination Status of HPV Vaccine Among Healthcare Students at a Tertiary Healthcare Center in Western India. The Journal of Obstetrics and Gynecology of India, 1-8.

[15]. Kato, M., Serretti, A. (2018). Review and meta-analysis of antidepressant pharmacogenetic findings in major depressive disorder. Molecular Psychiatry, 23(5), 1345-1355.

[16]. Amol Kulkarni "Digital Transformation with SAP Hana", International Journal on Recent and Innovation Trends in Computing and Communication ISSN: 2321-8169, Volume: 12 Issue: 1, 2024, Available at: https://ijritcc.org/index.php/ijritcc/article/view/10849

[17]. Hicks, J. K., Bishop, J. R., & Sangkuhl, K. (2015). Clinical Pharmacogenetics Implementation Consortium (CPIC) guideline for CYP2D6 and CYP2C19 genotypes and dosing of selective serotonin reuptake inhibitors. Clinical Pharmacology and Therapeutics, 98(2), 127–134.
[18]. BK Nagaraj, "Artificial Intelligence Based Mouth Ulcer Diagnosis: Innovations, Challenges, and Future Directions", FMDB Transactions on Sustainable Computer Letters, 2023.
[19]. TS K. Anitha, Bharath Kumar Nagaraj, P. Paramasivan, "Enhancing Clustering Performance with the Rough Set C-Means Algorithm", FMDB Transactions on Sustainable Computer Letters, 2023.
[20]. Fusar-Poli, P., Meyer-Lindenberg, A. (2013). Striatal presynaptic dopamine in schizophrenia, part II: meta-analysis of [18F/11C]-DOPA PET studies. Schizophrenia Bulletin, 39(1), 33-42.
[21]. Chekroud, A. M., Zotti, R. J., Shehzad, Z., Gueorguieva, R., Johnson, M. K., Trivedi, M. H.,... & Krystal, J. H. (2016). Cross-trial prediction of treatment outcome in depression: a machine learning approach. The Lancet Psychiatry, 3(3), 243-250.
[22]. Firth, J., Torous, J., Nicholas, J., Carney, R., Pratap, A., Rosenbaum, S., & Sarris, J. (2017). The efficacy of smartphone-based mental health interventions for depressive symptoms: a meta-analysis of randomized controlled trials. World Psychiatry, 16(3), 287–298.
[23]. Sravan Kumar Pala, "Synthesis, characterization and wound healing imitation of Fe3O4 magnetic nanoparticle grafted by natural products", Texas A&M University - Kingsville ProQuest Dissertations Publishing, 2014. 1572860.Available online at: https://www.proquest.com/openview/636d984c6e4a07d16be2960caa1f30c2/1?pq-origsite=gscholar&cbl=18750
[24]. Credit Risk Modeling with Big Data Analytics: Regulatory Compliance and Data Analytics in Credit Risk Modeling. (2016). International Journal of Transcontinental Discoveries, ISSN: 3006-628X, 3(1), 33-39.Available online at: https://internationaljournals.org/index.php/ijtd/article/view/97
[25]. Carhart-Harris, R. L., Goodwin, G. M. (2017). The therapeutic potential of psychedelic drugs: past, present, and future. Neuropsychopharmacology, 42(11), 2105-2113.
[26]. Banerjee, Dipak Kumar, Ashok Kumar, and Kuldeep Sharma.Machine learning in the petroleum and gas exploration phase current and future trends. (2022). International Journal of Business Management and Visuals, ISSN: 3006-2705, 5(2), 37-40. https://ijbmv.com/index.php/home/article/view/104
[27]. Fava, M. (2003). Diagnosis and definition of treatment-resistant depression. Biological Psychiatry, 53(8), 649-659.
[28]. Patel, M., Parikh, H., & Dave, G. (2023). Chitosan flakes-mediated diatom harvesting from natural water sources. Water Science & Technology, 87(7), 1732-1746.
[29]. Jeste, D. V., & Vahia, I. V. (2008). Comparison of the conceptualization of wisdom in ancient Indian literature with modern views: focus on the Bhagavad Gita. Psychiatry, 71(3), 197-209.
[30]. Sareen, J., Jacobi, F., Cox, B. J., Belik, S. L., Clara, I., & Stein, M. B. (2006). Disability and poor quality of life associated with comorbid anxiety disorders and physical conditions. Archives of Internal Medicine, 166(19), 2109-2116.
[31]. Goswami, MaloyJyoti. "AI-Based Anomaly Detection for Real-Time Cybersecurity." International Journal of Research and Review Techniques 3.1 (2024): 45-53.
[32]. Insel, T. R., & Quirion, R. (2005). Psychiatry as a clinical neuroscience discipline. JAMA, 294(17), 2221-2224.
[33]. Nutt, D. J., King, L. A., & Phillips, L. D. (2010). Drug harms in the UK: a multicriteria decision analysis. The Lancet, 376(9752), 1558-1565.
[34]. Cuthbert, B. N., & Insel, T. R. (2013). Toward the future of psychiatric diagnosis: the seven pillars of RDoC. BMC Medicine, 11(1), 126.
[35]. Pillai, Sanjaikanth E. VadakkethilSomanathan, et al. "Beyond the Bin: Machine Learning-Driven Waste Management for a Sustainable Future. (2023)."Journal of Recent Trends in Computer Science and Engineering (JRTCSE), 11(1), 16–27. https://doi.org/10.70589/JRTCSE.2023.1.3
[36]. Riva-Posse, P., Choi, K. S., Holtzheimer, P. E., McIntyre, C. C., Gross, R. E., Chaturvedi, A.,... & Mayberg, H. S. (2017). Defining critical white matter pathways mediating successful subcallosal cingulate deep brain stimulation for treatment-resistant depression. Biological Psychiatry, 82(12), 938-946.