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The Classification of Depression and the Role of Nanomedicine in its Treatment

Muhammad Sikandar Hayat[1], Arslan Muhammad Ali Khan[2], Danish Ali Shahid[3], Sarmad Nasir[4]

[1]Roots Ivy International Faisalabad, Pakistan
[2]Department of Parasitology, University of Agriculture, Faisalabad, Pakistan
[3]Department of Emergency Medicine, Combined Military Hospital Gujranwala/National University of Medical Sciences, Pakistan
[4]Department of ENT, Allied Hospital Faisalabad, Pakistan
*Corresponding author: **arslanrajpootkhan374@gmail.com**

ABSTRACT

The most prevalent mental disorder associated with stress is depression. It affects millions of people all around the world. Its development may involve influences from the biochemical, psychological, environmental, and genetic domains. Psychotherapy, medication, and lifestyle modifications are commonly employed in the treatment of depression. The way antidepressant drugs function is by changing the amounts of specific molecules in the brain. The illness's present treatment plan includes several disadvantages, including side effects, inefficiency, long-term usage, stigma, and problems with the medication's cost. These side effects highlight the importance of more effective and cutting-edge approaches to treating anxiety, such as research into nanotechnology-based medicine delivery technologies. The possible advantages of using nanotechnology in the treatment of depressive disorder include greater drug effectiveness, fewer adverse reactions, fewer long-lasting medication effects, an improved comprehension of the neural mechanisms of sadness, and the possibility for the creation of specific medicines.

Introduction

Currently, depression is the primary cause of disability globally, affecting approximately 300 million individuals. Less than 40% of patients with major depressive disorder (MDD) experience recovery after the first course of treatment, even though there are numerous therapeutic options available. Gaining more knowledge about the neurological underpinnings of depression symptoms could facilitate the creation of new therapeutic targets and efficacious interventions, thereby mitigating the impact of depression and enhancing the quality of life for individuals afflicted with the illness [1]. Patients with depressive disorders have a wide range of clinical presentations. In general, depressive symptoms can be classified into three dimensions.

Psychological Symptoms or Psychological Disorders

Additionally, referred to as mental diseases or mental health issues are psychological disorders. Your relationships and daily functioning may be influenced, as they have the potential to alter your thoughts, feelings, and actions. Both transient and permanent problems are possible. Psychological disorders related to mental health are widespread [2]. A psychiatric condition affects one in five adults in the United States annually, according to estimates from the National Alliance on Mental Illness. It is a wide term that generally encompasses the main signs and symptoms of depression along with thoughts of suicide, feelings of guilt, and worthlessness. Psychological problems can be treated, even though they might be difficult to live with. Medication, self-care techniques, and talk therapy can all help those with psychiatric problems operate better [3]. Many experts believe that inflammation is a key factor in the onset of psychological diseases. Increased levels of inflammatory markers in the blood, including interleukin (IL)-1β, IL-6, tumor necrosis factor (TNF)-α, and C-reactive protein (CRP), have been observed in mental disease disorders (MDD) patients. Significantly, these rises have been linked to worse antidepressant treatment outcomes. Regional inflammatory reactions can signal the brain through several channels, including the vagus nerve, blood-brain barrier leaky areas, and cytokine transport systems, resulting in significant depression [4].

Peripheral cytokines via these pathways can influence the central production and uptake of amine neurotransmitters, such as norepinephrine, serotonin, and dopamine. These results support the hypothesis that inflammation may modify brain chemistry and have a role in the onset and course of MDD.

Since interferon (IFN) stimulates the release of anti-inflammatory cytokines, IFN treatment has gained popularity as a standard procedure for investigating depression brought on by inflammation [5].

Cognitive symptoms

Patients with MDD may have cognitive abnormalities in attention, management of emotions, thinking speed, and verbal and visual memory, according to formal neurocognitive testing. The majority of the examined studies used one or two self-reported or observer-rated items to assess dementia. Significant depression has been associated with impairment in several cognitive categories, many of which depression tests fail to measure. Furthermore, it is difficult to interpret the data because five studies identified "indecisiveness" and/or "difficulty concentrating" as neurovegetative symptoms. only two studies used unbiased assessments of cognition [6]. According to one study, higher levels of inflammatory reactions were linked to lower executive functioning across the board (i.e., not just in the MDD group but also in the healthy control group and patients with MDD). No correlation was observed between CRP and executive function or attention in MDD, according to another study.

Neurovegetative symptoms

The neurovegetative element is often used to categorize a variety of symptoms, including fatigue, sleep, and psychomotor retardation. Most of the reviewed studies combined these symptoms into a sum score that indicated the level of severity for the neurovegetative dimensions. Crucially, though, these notions might have different underlying etiologies [7]. Following that, these concepts are explored independently in the circumstances of the studies reviewed, and their correlations with inflammatory diseases and disorders are addressed in the literature.

Psychomotor retardation

Psychomotor retardation has been defined as a neurovegetative symptom in the majority of research investigations; however, one study classed this item as a sign of low mood. The dual nature of psychomotor retardation, its motor and cognitive components may account for the discrepancies in how this concept is categorized. Certain exams evaluate the motor and/or cognitive aspects. The digit pattern substitution test, for instance, can evaluate both motor and mental skills. The finger-tapping test, on the other hand, measures only motor performance. This article includes just two research that used objective measurements of psychomotor processing. One study discovered that throughout the sample, which included both healthy controls and MDD patients, increased inflammation was linked to worse psychomotor speed [8].

Using the finger-tapping test, another study objectively assessed motor processing speed and discovered a correlation between increased CRP and slower motor speed. Further research is required to define this link by objectively measuring the motor and cognitive aspects of MDD patients.

Fatigue

One typical symptom of inflammation-induced depression is exhaustion; after receiving IFN therapy, for instance, weariness is frequently noted. Studies using neuroimaging have demonstrated changes in the root ganglia after long-term exposure to this kind of inflammation. For instance, patients receiving IFN have shown improvements in basal ganglia glutamate concentrations and glucose metabolism, both of which are connected with sensations of weariness. Both the physical and mental aspects of fatigue such as attention have been connected to different underlying neurobiologies, which is significant. All things considered, a little study has been done to examine the underlying inflammation and to sort through the variability of fatigue in the setting of inflammation-associated depression [9].

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Core symptoms

Depressed mood

Six research distinguished "depressed mood" as a distinct dimension, however the majority of the examined studies categorized depression under the cognitive dimension. Out of the four investigations, two revealed no data, and the other two discovered a positive correlation between inflammation and symptoms of depression. In the latter case, this specific item may have had a significant impact on the correlation that was shown between inflammation and depression. All in all, these findings provide credence to the idea that inflammation is a long-term predictor of depression [10]. A meta-analysis study showed evidence to back up the association between inflammation and the overall depressed symptomatology that followed. All of these results point to the possibility that inflammation has a role in the emergence of depression along with various depressive symptoms, maybe via modifying neuropathway activity.

Anhedonia

Loss of interest or pleasure was categorized as a cognitive symptom in the majority of the examined research, although three studies classed it as a neurovegetative syndrome. Irrespective of additional depressed symptoms, only one examined study found a slightly positive correlation between one aspect of anhedonia and inflammation. In a different study involving MDD patients, greater glutamate content in the left basal ganglia and decreased connection between the ventral striatum were linked to elevated plasma CRP, which was also correlated with anhedonia.

Finally, the investigation reported that interleukins particularly IL-4, IL-7, IL-9, tumor necrosis factors, and non-T cells- cytokines are associated with anhedonia in mental disorder patients. Additional evidence supporting these connections comes from clinical investigations where inflammation is generated. For instance, patients receiving IFN showed decreased activity in the ventral striatum in response to pleasant stimuli, and this activity was connected with higher anhedonia scores [11].

Treatment of depression by Nanomedicine:

The application of nanotechnology to the biomedical domain is known as nanomedicine, and it focuses on developing more intelligent delivery systems to maximize the in vivo efficacy of medicinal molecules as well as their usage in medical imaging and diagnostics. Although particles in the size range of 1–100 nm are commonly associated with nanotechnology, the word nanomedicine is less restrictive and refers to the application of particles in the size range of a few nanometers to 1000 nm (12).

Furthermore, attempts at nanomedicine may also include micro-sized systems incorporating nanostructures. To maximize the administration of treatments, the most widely used nanomedicine techniques in recent years have been liposomes, dendrimers, polymeric micelles or nanoparticles, solid lipid nanoparticles, nanostructured lipid carriers, and nano emulsions. Numerous research has been published that attempt to improve the oral delivery of psychiatric medications by addressing some of their stated limitations (13). These diverse advanced delivery systems provide the ability to control and enhance drug delivery via multiple methods.

Currently, there isn't a thorough evaluation of the application of nanomedicine techniques to improve oral administration of psychiatric medications [14]. The current study emphasizes the different obstacles to effective oral delivery of psychotropic medications, and it goes into great detail about the most recent advances in this area, with a focus on oral lipid-based delivery methods for drugs and polymer-based nanocarriers, which are the most widely used nanomedicine approaches [15].

Lipid-based drug delivery systems

It has long been established that lipids can improve the gastrointestinal absorption and bioavailability of medications that are poorly soluble in water. Lipids and lipid emulsifiers can affect drug absorption through three primary mechanisms: The GI environment can be altered in three ways: (i) by increasing intestinal lymphatic drug transport, which lowers hepatic first-pass metabolism; (ii) by interacting with enterocytes and their drug transport processes, which can inhibit intestinal efflux and metabolism. Lipid-based drug delivery systems, or LBDDS, could therefore be taken into consideration as a possible formulation approach for a number of psychiatric medications. From basic lipid solutions and suspensions to more complex self-emulsifying compositions or lipid-based colloidal drug carriers, the term "lipid-based drug delivery systems" (LBDDS) covers a broad range of lipid-based formulation techniques.

Nano-neurostimulation:

As we already know, depression symptoms can be lessened by stimulating particular brain regions. Repetitive transcranial magnetic stimulation, or rTMS, is proof of this. It is well-established that repetitive TMS (rTMS) in the left prefrontal cortex lessens depression. Moreover, depression symptoms may be mitigated by neural implants or implanted electrodes that activate the brain's pleasure region [17].

Polymeric nanoparticles:

These are microscopic particles that transport chemicals to certain areas within particular cells. Polymeric nanoparticles may both protect the medication and make it more likely that it will reach a certain section of the brain. These have the additional ability to enhance the duration of medication release and open the blood-brain barrier [18].

Conclusion

The discipline of nanomedicine will keep developing—possibly at an exponential or even faster rate with each year that goes by. It will not be too much longer before neuroscientists can identify therapeutic uses for nanomedicine in the management of neurological conditions. The consequences of using nanotechnology and nanomedicine for the treatment of depression will need to be taken into account as these fields continue to garner public interest and show promise.

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