

## Neuromechanism in producing obsessions and compulsions: etiology and management criteria

Swarna Priya B<sup>1\*</sup>, Aravind Raj J<sup>2</sup>, Heeba Begum J<sup>3</sup>

### ABSTRACT

Obsessive Compulsive Disorder (OCD) is a neurobehavioral disease characterized by repeated Obsessions and Compulsions leading to severe behavioural changes. Sometimes general public and even health care professionals tend to disregard OCD symptoms with Anxiety disorder. This disorder is long-term and often is unnoticed and under-diagnosed which leads to poor therapy and deprived therapeutic outcomes. Developing a patient-centred care and therapy requires major information such as Medical History, Genetic Factors, etiology and Pathophysiology of the disease, Demographic factors, Lab values and much more, in which etiology and pathophysiology plays an essential character. Keeping all these things in mind, the current review deals with the explained version of etiology and pathology of Obsessive-Compulsive Disorder to provide further unobserved information and up-to-date version in supplying necessary details about OCD for the improvement of conventional and appropriate drug-therapy regimen.

**Keywords:** *Obsessive Compulsive Disorder, Neurobehavioral Disease, Therapeutic Outcomes, Etiology, Pathophysiology, Drug-therapy Regimen.*

Obsessive Compulsive Disorder (OCD) is a specific type of Anxiety Disorder, characterized with Obsessions and Compulsions. Obsession is a recurrent, intrusive thoughts, difficult to get out of brain and cause anxiety leading to Compulsion. Compulsion is an action to reduce the anxiety associated with obsession; it includes imaginations, thoughts and rituals and has a serious impact on other daily life activities. Obsessive Compulsive Disorder (OCD) is a common, chronic and long-lasting disorder in which a person has uncontrollable, reoccurring thoughts (obsessions) and behaviors (compulsions) feeling the urge to repeat over and over again. An obsession is defined as an idea, impulse, or image which intrudes into the conscious awareness repeatedly. OCD was classified under anxiety disorder in DSM-4 but the DSM-5 chapter on anxiety disorder no longer includes obsessive-compulsive disorder (which is included with the obsessive-

<sup>1</sup>Doctor of Pharmacy V year, Department of Pharmacy Practice, Jaya College of Pharmacy, Thiruninravur, Chennai, Tamil Nadu, India.

<sup>2</sup>Doctor of Pharmacy V year, Department of Pharmacy Practice, EGS Pillay college of Pharmacy, Nagapattinam, India.

<sup>3</sup>Doctor of Pharmacy V year, Department of Pharmacy, Annamalai University, Annamalai Nagar, Chidambaram, India.

[\\*Responding Author](#)

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compulsive and related disorders separately). This is also reflected in the ICD 10 classification which lists OCD as a separate entity from anxiety disorder. Sims textbook of psychopathology states that, "Certainly OCD is not an anxiety disorder. Isolated obsession or obsessive-compulsive disorder may occur with or without anxiety, with or without depression and with or without personality disorder. It is a distinct and separate phenomenon". The Epidemiology of OCD was found to have a lifetime prevalence of 2.5% in the study. Notably, 30-50% of patients develop OCD starting in childhood. Lifetime prevalence is generally in the range of 1.7-4%. The incidence of OCD is higher in dermatology patients and cosmetic surgery patients, and prevalence among adult and children are same. It is found that 25% chronic schizophrenic patients have OCD symptoms (with poor prognosis) and British Epidemiology found a gender ratio of 1.4 to 1 (women to men). Abnormalities in other parts of the brain and an imbalance of brain chemicals, especially serotonin, may also contribute to OCD. Some experts believe that a problem related to streptococcal infections, such as streptococcal throat infection and scarlet fever can suddenly bring on the disorder or make its symptoms worse in some children. Taking severe prevalence into consideration, the current review article elucidates and unfolds the facts and information on etiology of Obsessive-Compulsive Disorder, providing clarity for advancement of drug-therapy regimen for better patient outcomes. Recurrent & persistent thought, impulses, or images that are experienced, at some time during the disturbance, as intrusive and inappropriate and that cause marked anxiety or distress. The thoughts, impulses, or images aren't simply excessive worries about life problems. The person attempts to ignore or suppress such thoughts, impulses, or images to neutralize them with some other thoughts or actions. The person recognizes that the obsession thoughts, impulses, or images are a product of his/her own mind (not imposed from without as in thought insertion). Repetitive behaviors (hand washing, ordering, checking) and mental acts (praying, counting, repeating words silently) make the person driven to perform in response to an obsession, or according to rules that must be applied rigidly. The behaviors or mental acts are aimed at preventing or reducing distress or preventing some dreaded event or situation; however, these behaviors or mental acts either are not connected in a realistic way with what they are designed to neutralize or prevent or are clearly excessive. Common compulsions (Behaviors) are hand washing (so repetitive that they become raw), counting (how many cards in a deck, over and over again), cleaning (spots on windows), checking (the lights to make sure they're off; locked doors every few minutes). Fig 1 describes in detail OCD which is driven by the fear of consequences and the individuals with these conditions perform compulsive or avoidant behaviors in an effort to condense their anxiety. Unfortunately, while performing these behaviors at first may reduce the anxiety, but it actually reinforces and worsens it in the long-term. This in turn leads to an increase in compulsive or avoidant behaviors, which leads to even added anxiety. While the specific thoughts and behaviors may differ with each of these disorders, this cyclical process is identical.



**Fig 1: The vicious cycle of OCD: showing the stages of Obsessions, anxiety, compulsions and relief factor.**

The current article describes various etiological factors and management criteria and strategy for development of personalized medicine and patient-centric care system thereby improving the outcomes and patient's quality of life.

## **ETIOLOGY**

The etiology of the disease or a condition serves as the main base for the development of treatment regimen (both non-pharmacological and pharmacological). Etiology is the study of causes, origins and reasons behind the function. This includes vast factors ranging from extrinsic (exposure) to intrinsic (genetic, metabolic) determinants. The following are the category of factors responsible for the development of OCD.

1. Genetic factors
2. Biological casual factors
3. Psychosocial Causal factors
4. Behavioral factors
5. Environmental factors
6. Cognitive Causal factors

### **Genetic factor**

OCD has significant genetic component in which three to five times higher probability in relatives of probands with OCD. Concordance for OCD in twins is significantly higher for monozygotic twins than for dizygotic twins. Twin studies have supported strong heritability for OCD, with a genetic influence of 45-65% in studies in children and 27-47% in adults. Monozygotic twins may be strikingly concordant for OCD (80-87%), compared with 47-50% concordance in dizygotic twins. Several genetic studies have supported linkages to a variety of serotonergic, dopaminergic, and glutamatergic genes.

### **Biological causal factors**

The biological determinants of OCD include neurotransmitters and the defect in inhibitory and excitatory neuromechanisms leading to interruptions in default settings. These neurotransmitters include serotonin, dopamine, glutamate and copper. There is a Dysregulation of serotonergic system resulting in severe changes in normal neurochemistry.

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Affinities of platelet serotonin radiolabeled imipramine binds to serotonin reuptake site and reported variable finding of these measures in OCD. Certain studies have also stated the decreased level of 5HIAA after treatment with clomipramine and normalization of platelet transporter after treatment with clomipramine. Although research suggests that alteration of brain serotonergic systems may be one of the mechanisms through which SSRIs have their therapeutic effects, there is no evidence of baseline serotonergic dysfunction in OCD patients.

Some forms of OCD are etiologic related to Tourette Syndrome. TS appear to be predominantly dopaminergically mediated, as evidenced by the well-documented clinical response to haloperidol and other dopamine antagonists. OCD patients with comorbid disorder or Tourette Syndrome are usually resistant to conventional pharmacotherapy with proserotonergic compounds and may benefit from adjuvant treatment with dopamine (DA) or DA/5-HT blockers. This suggests that there is an involvement of Dopamine in at least some OCD patients. The serotonin and dopamine systems interact extensively, particularly in the basal ganglia (an area that has been implicated in the pathogenesis of obsessive-compulsive phenomenology by several studies). Although modulated by serotonin and other neurotransmitters, the synapses in the cortico-striato-thalamo-cortical circuits thought to be centrally involved in the pathology of OCD principally employ the neurotransmitters glutamate and Gamma Amino Butyric Acid (GABA). CSF glutamate concentration was significantly greater in OCD patients as compared with control subjects. Indeed, glutamate and serotonin interact on a number of levels in the frontal striatal circuit. Therefore, the persistence of symptoms despite targeting serotonin and glutamate pharmacologically indicates limits of the serotonin and glutamate hypothesis of OCD. Attention has also been focused on glutamatergic abnormalities and possible glutamatergic treatments for OCD.

Elevated copper and corresponding changes in dopamine may result in increased number or sensitivity of post-synaptic dopamine receptors in certain areas of the brain. Association between ceruloplasmin and OCD might be examined through ceruloplasmin and copper relationship since there is now growing evidence that the dopamine system may be involved also in the pathophysiology of OCD. However, association between ceruloplasmin and OCD may be explained via copper and serotonin relationship.

### ***Psychosocial casual factors - Psychoanalytic theory***

Freud proposed a theory on patient's mind response maladaptively to conflicts between unacceptable, unconscious sexual or aggressive, and the demands of conscience and reality. It regressed to concerns with control and to modes of thinking characteristic of the anal-sadistic stage of:

1. *Ambivalence* - This produces doubting,
2. *Magical thinking* – This produces superstitious compulsive acts

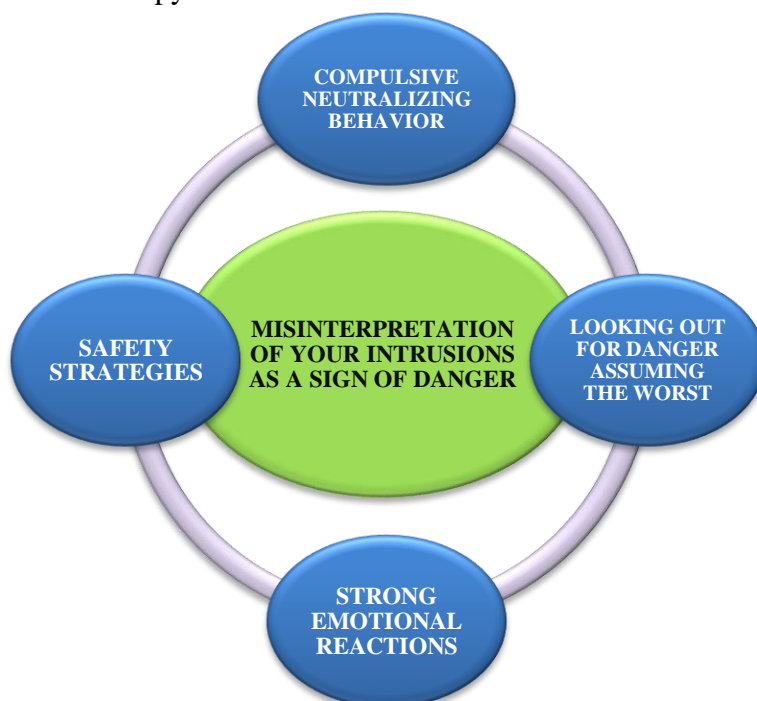
The imperfect success of these defenses gave rise to OCD symptoms like anxiety; preoccupation with dirt or germs or moral questions; and, fears of acting on unacceptable impulses.

### ***Behavioral factors***

The behavioral theory suggests that people with OCD correlate certain objects or situations with fear. These factors associated with fear are behavioral factors. They learn to avoid those things or learn to perform “rituals” to help reduce the fear. Once the connection between an object and the feeling of fear becomes established, people with OCD begin to evade that

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object and the fear it generates, rather than confronting or tolerating the fear. Fig 3 shows the negative reinforcement of thoughts of Exposure Response Prevention (ERP) which helps to reduce the misinterpretation of intrusions by facing the fear (the danger factor) and to better process the false information. Mowrer's two process theory of avoidance learning (1947): According to this theory, neutral stimuli become associated with frightening thoughts or experience through classical conditioning and come to elicit anxiety. This model predicts, then, that exposure to feared objects or situations should be useful in treating OCD if the exposure is followed prevention of the rituals, enabling the person to see that the anxiety will subside naturally in time without the ritual. This indeed is the cure of the most effective form of Behavioral therapy for OCD.



**Fig 2: Negative reinforcement of thoughts: The compulsive behaviour produces the thoughts of assuming danger (something worst) and this creates strong emotional reactions in individuals mind leading to the development of safety strategies.**

### ***Environmental factor***

A number of environmental factors may contribute to the onset and maintenance of OCD. Although some research suggests no link between negative life events and OCD, there are many reports in which childhood OCD has been triggered by a specific often traumatic event like the death of a loved ones, the loss of a pet, a divorce in the family etc.

Furthermore, a recent study indicated that, those one to two years prior to the onset of symptoms, both children and adults who develop OCD experience more negative life events than controls. Taken together, these results suggest that stress or trauma can play a role in the development of OCD among certain individuals. The results of a study show that 80 children and adolescents who suffered a traumatic brain injury were examined, indicated that almost 30% of the young people had new onset of obsessive-compulsive symptoms within one year after the serious injury.

In a study, Berthier and colleagues (2001) assessed 10 referred patients who had developed OCD after Traumatic Brain Injury and found peculiar symptoms of obsessive slowness in 3

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cases and compulsive exercise practice in 3 cases also (1 of which had both symptoms). Grados states that obsessive-compulsive phenomena following brain injury are probably more common than generally expected, most symptoms have an early onset.

### ***Cognitive causal factors***

Many cognitive theorists believe that individuals with OCD have faulty or dysfunctional beliefs, and that it is their misinterpretation of intrusive thoughts that leads to the creation of obsessions and compulsions. According to the cognitive model of OCD, everyone experiences intrusive thoughts. People with OCD, misinterpret these thoughts as being very important, personally significant, revealing about one's character, or having catastrophic consequences. The Obsessive-Compulsive Cognitions Working Group, an international group of researchers who have proposed that the onset and maintenance of OCD are associated with maladaptive interpretations of cognitive intrusions, has identified six types of dysfunctional beliefs associated with OCD.

1. **Inflated sense of Responsibility:** A belief that one has the ability to cause and/or is responsible for preventing negative outcomes; This sense of inflated responsibility for the harm they may cause adds to the perceived awfulness of any harmful consequences and may motivate compulsive behaviors like washing and checking to reduce the likelihood of the event.
2. **Over importance of thoughts (thought action fusion):** The belief of having a bad thought can influence the probability of the occurrence of a negative event or that having a bad thought (about doing something) is morally equivalent to actually doing it.
3. **Control of thoughts:** A belief that it is both essential and possible to have total control over one's own thoughts.
4. **Overestimation of threat:** A belief that negative events are very probable and that they will be particularly bad.
5. **Perfectionism:** A belief that one cannot make mistakes and that imperfection is unacceptable.
6. **Intolerance for uncertainty:** A belief that it is essential and possible to know, without a doubt, that negative events won't happen.

People with normal and abnormal obsessions differ primarily in the degree to which they resist their own thoughts. The factor contributing to the frequency of obsessive thoughts and negative moods is the attempt to suppress them.

### ***The Autoimmune Hypothesis***

An association was drawn between infection with group A hemolytic Streptococcus (as well as other agents, including viruses), and the onset or the exacerbation of OCD in some children. The 10 to 30% of patients of rheumatic fever develop Sydenham's chorea and show symptoms of OCD and it is found that Pediatric Autoimmune Neuropsychiatric Disorder Associated with Streptococcus (PANDAS). PANDAS form of OCD is rapid in onset and Occurs in close association with streptococcal infections. Usually have involuntary movements of the arms, legs and on face. Few recent studies report the herpes simplex virus as the apparent precipitating infectious event. Increasing evidence linking streptococcal infection to OCD in children suggests that microbiomics may prove an important research area for understanding and treating mental disorders.

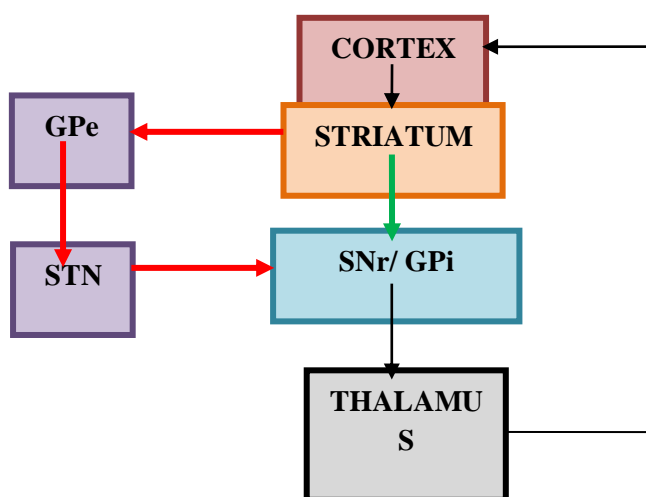
### *Changes in brain activity*

Modern brain imaging techniques have shown that people with OCD have more than usual activity in three areas of the brain. These are:

1. Orbital Frontal Cortex (OFC),
2. Anterior Cingulate Cortex and
3. Caudate nucleus of the basal ganglia

The OFC and ACC are intricately connected to the basal ganglia via the cortico—basal ganglia— thalamocortical loops. Computed Tomography and Magnetic Resonance Imaging have shown decreased size of caudate nucleus bilaterally. Positron Emitted Tomography scan has also shown increased activity in the frontal lobe, caudate nucleus, and the cingulum of patients. The caudate nucleus, specific brain cells in basal ganglia is the area of the brain acts as a filter for thoughts coming in from other areas. The caudate nucleus is also considered to be important in managing habitual and repetitive behaviors. The prefrontal orbital cortex located in front area of brain is believed to affect appropriate social behavior. Lowered activity or damage in this region is linked to feeling uninhibited, making bad judgments and feeling a lack of guilt. More activity may therefore cause more worry about social concerns.

The cingulate gyrus in the centre of brain is believed to contribute the emotional response to obsessive thoughts. This area of the brain sends signals to perform compulsions to relieve anxiety. This region is highly interconnected to the prefrontal orbital cortex and the basal ganglia via a number of brain cell pathways. Brain scans of people with OCD have shown that they have different patterns of brain activity than people without OCD, and that abnormal functioning of circuitry within a certain part of the brain (striatum) may cause the disorder. Current theories suggest OCD as the result of an imbalance between “direct” & “indirect” pathways. Direct pathways run from the cortex to the striatum, then to the GPi and SNr, then to the thalamus, and finally back to the cortex.



**Fig 3: Pathophysiology of OCD: Direct and Indirect pathways not balanced: Direct pathway >>Indirect pathway. Glatamatergic (excitatory) and GABAergic (inhibitory) pathways explained. SNr - substantia nigra pars reticulata, GPi - GlobusPallidus interna, STN - subthalamic nucleus, GPe - Globus pallidus externa.**

The indirect pathways are described as running from the cortex to the striatum, then to the GPe, the STN, the GPi and SNr, then thalamus, finally back to cortex. Fig 3 shows the

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pathophysiology of OCD with multiple neurons involved. While the net effect of the direct pathway is excitatory, the net effect of the indirect pathway is inhibitory; OCD may result from excessive neural tone in the direct pathway relative to the indirect pathway resulting in a positive feedback loop whereby obsessive thoughts are trapped. There is a broad consensus for widely distributed abnormalities involving fronto-striatal circuits in OCD. Moreover, reversal of orbitofrontal cortex (OFC) dysfunction after treatment has also been reported in certain patients.

### *Criteria for Management*

Management and treatment goals are the first and foremost plans to be made after diagnosing OCD. Common ingredients of managing OCD include the following:

1. Detailed assessment of symptoms and comorbid patterns including suicidal behaviors either by unstructured clinical interview alone or supplementation with structured assessments.
2. Decision on setting for treatment (outpatient vs. inpatient care depending upon the severity, treatment resistance etc.).
3. Detailed psychoeducation of the patient and family member (s) about OCD, its course and treatment options including duration of treatment.
4. Choice of treatment: drugs vs. CBT vs. combination.
5. In the Indian context, SSRIs are first-line treatments preferred over CBT because of feasibility, affordability and limited number of trained therapists. CBT may be considered if SSRIs alone are not beneficial.
6. Discussion on side-effects of drugs; in women risks vs. benefits of drugs during pregnancy and in the post-partum period.
7. Follow-up plan after initiating treatment.

The treatment goals are made to begin the development of drug therapy regimen and the factors affecting are as follows:

1. **Past medical history:** The history interview must be planned in such a way, to get utmost information, with least trouble and time to the patient. Medication histories are vital in preventing prescription errors and consequent risks to patients. Apart from preventing prescription errors, accurate medication histories are also functional in detecting drug-related pathology or changes in clinical signs that may be the result of drug therapy.
2. **Demographic factors:** Demographic factors such as age, sex, height and weight also take a long way on developing drug therapy regimen. On addition, Clark's formula and Young's formula are used to determine the dose of drugs according demography of the patient.
3. **Socioeconomic status:** Socioeconomic status not only describes the economic level of the patient's family, but also the lifestyle one is in. Thus, depending on the SES the healthcare team has to calculate the cost analysis and come-up with a plan of choice which can be affordable bringing about equity.
4. **Occupation:** Depending upon the occupation one's regimen has be developed so as to make changes in the frequency of drug intake and while making non-pharmacological therapies.
5. **Current alternative medicine use:** Use of other alternative substances such as Siddha, Ayurveda, Unani, Homeopathy also plays a major role in disturbing the metabolism of drugs inside the body. Thus, the patient should be carefully enquired about the use of alternative medicine.



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6. **Lab values:** The pharmacokinetic properties involve ADME (Absorption, Distribution, Metabolism and Excretion) activities and the major organs related to this process are Liver and Kidney as they play a chief part in metabolism of drugs and elimination. Sometimes Liver not only does metabolism but also involves itself in elimination of drugs through Bile. Thus, the Liver Function Tests and Kidney Function Tests must be done in order to check and monitor the levels of enzymes and therefore we can detect the abnormalities and try for alternating other drugs which doesn't get eliminated through this route. Other parameters such as half-life of the drug, elimination rate, absorption rate, metabolism rate also should be considered.
7. **Other co-morbidities:** The co-morbidities are responsible for interfering Pharmacodynamic properties and can therefore be a barrier for our desired outcome of the drug therapy. Thus, any co-morbid conditions or disease should be noted.
8. **Synergism and Antagonism:** Drugs within the regimen can interact easily resulting in synergistic or antagonistic reactions not leading to our desired outcome. Therefore, the drugs in the regimen should be scanned for producing any Drug interactions to keep everything on check and this can be prevented by changing the frequency of intake or route of administration.

### *Personalized medicine*

Personalized medicine can be applied to new and transformative approaches to healthcare and can be an essential tool in evaluating health risks and to tailor the drug-therapy regimen according to patient factors to mitigate risks, prevent disease and resulting in better therapy outcomes. This moves global health towards more precise, predictable and powerful future in which the healthcare can be customized for individual patients and our growing genetics and genomics drives this easy by providing better prevention and more accurate and effective diagnosis and treatment. In some cases, it is also noted to markup the disease-causing agent such as drug resistant bacteria and virus. Advances in Personalized medicine will create a more unified treatment approach for diverse people and provides earlier intervention, more efficient drug development and more targeted therapies. As the benefits of PM are infinite, the limitations of traditional healthcare system such as; trial and error way of treatment, consumption of time and cost, failure of clinical trials, side effects, medication errors, lack of disease detection and susceptibility to disease can be largely minimized by optimizing and holding the potential healthcare system and revolutionizing medical technologies and therapeutics. This serves as mountain feasibility for foster reformulating the existing healthcare system.

### *Social impacts*

The social impacts of OCD are complicated to understand and are Body dysmorphic disorder, Hoarding disorder, Suicidal thoughts, Severe Dermatological conditions and due to medication – Medication Addiction and Medication overdose Toxicity.

## **CONCLUSION**

OCD is a chronic and debilitating critical mental condition and understanding its etiology will be obliging in designing treatment which is directed towards pathology. The definitive cause or causes of OCD have not yet been identified; research continually produces new evidence that hopefully will lead to more answers in future. Also, in addition the management strategies should be studied in vast to understand the concept of developing drug therapy regimen well. The factors and parameters should be considered to change the narrow view and to include several information to customize and personalize the drug

therapy regimen in order to generate the desired outcome in a limited time with substantial efficiency.

### **Abbreviations**

OCD: Obsessive Compulsive Disorder; DSM: Diagnostic and Statistical Manual; DA: Dopamine, HT: Hydroxytryptamine; GABA: Gama Amino Butyric Acid; ERP: Exposure Response Prevention; PANDAS: Pediatric Autoimmune Neuropsychiatric Disorder Associated with Streptococcus; OFC: Orbital Frontal Cortex; ACC: Anterior Cingulated Cortex; SNr: substantia nigra pars reticulata; GPi: GlobusPallidus interna; STN - subthalamic nucleus; GPe - Globus pallidus externa; CBT: Cognitive Behavioral Therapy; SSRI: Selective Serotonin Reuptake Inhibitor; SES: Socio Economic Status; ADME: Absorption, Distribution, Metabolism and Excretion; PM: Personalized Medicine.

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