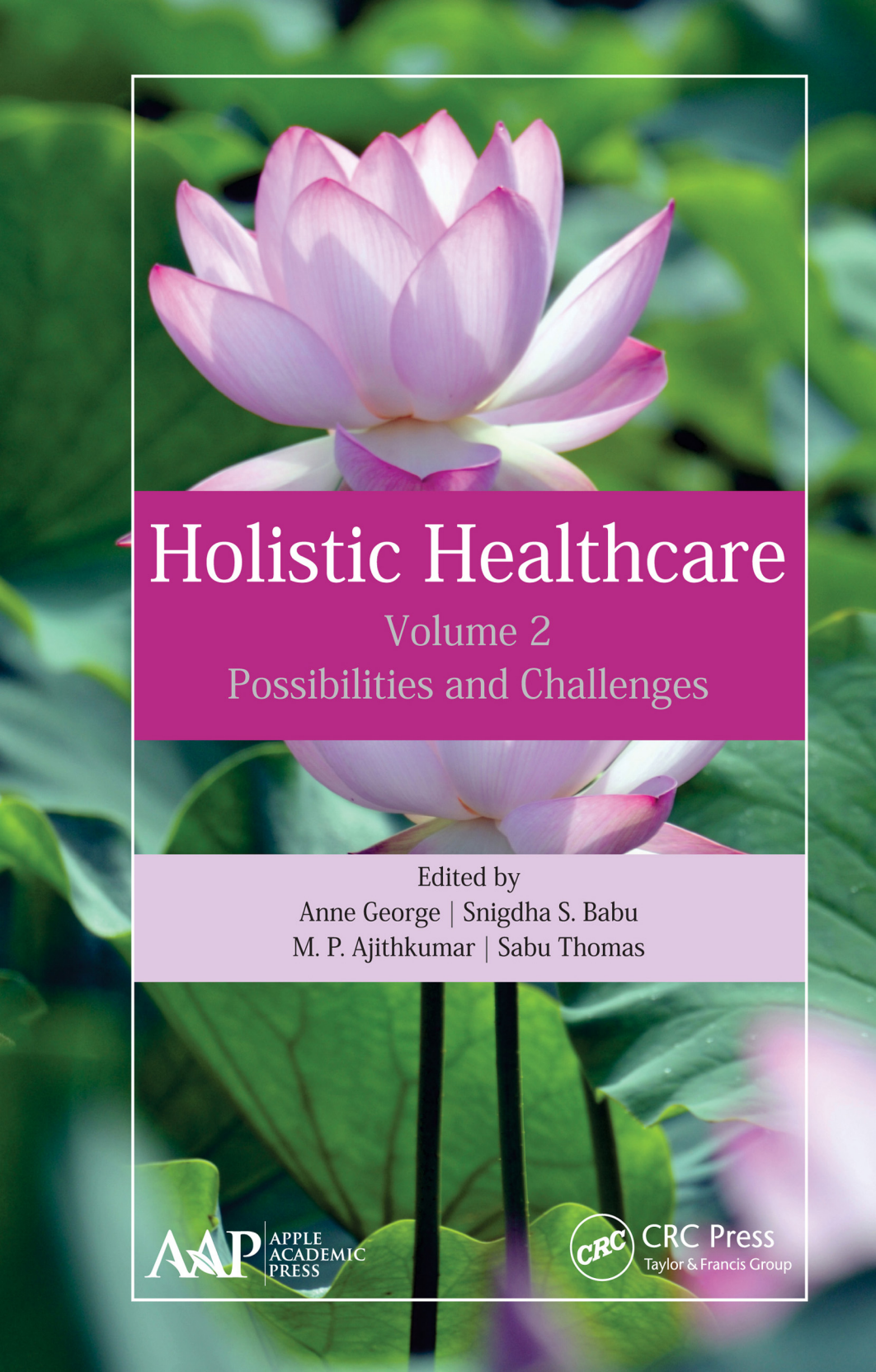

Holistic Healthcare

Volume 2
Possibilities and Challenges

Edited by
Anne George | Snigdha S. Babu
M. P. Ajithkumar | Sabu Thomas

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VOLUME 2

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LIST OF ABBREVIATIONS

5HT	serotonin
8-OHdG	8-hydroxy-2-deoxyguanosine
AChE	acetyl cholinesterase
ACP	acid phosphatase
ADHD	attention-deficit hyperactivity disorder
AE	adverse effect
AKT	autokinesiotherapy
ALS	advanced life support
ANOVA	analysis of variance
ART	assisted reproductive technology
BDI	Beck Depression Inventory
BLS	basic life support
BP	blood pressure
BSA	bovine serum albumin
CAM	complementary and alternative medicine
CCHR	Citizen's Commission on Human Rights
CGI	clinical global impression
CHD	chronic heart disease
CM	*Commiphora mukul*
CNS	central nervous system
CPF	chlorpyrifos
CPR	cardiopulmonary resuscitation
CV	cardiovascular
CVS	cardiovascular system
DASH	dietary approaches to stop hypertension
DBP	diastolic blood pressure
DD	depressive disorder
DHFWS	District Health & Family Welfare Samiti
DM	diabetes mellitus
DMO	Duty Medical Officer
DPD	dynamic pain display
EC	education control
EMRI	Emergency Management and Research Institute

EMS	emergency medical services
EQ-5D	EuroQol 5D
ERS	emergency response services
GAF	Global Assessment of Functioning
GR	glutathione reductase
HADS	Hospital Anxiety and Depression Scale
HDRS	Hamilton Depression Rating Scale
HPA	hypothalamic–pituitary–adrenal
ICSI	intracytoplasmic sperm injection
IPD	in patient department
ISH	isolated systolic hypertension
IVF	in vitro fertility
LDH	lactate dehydrogenase
LPO	lipid peroxidation
LTP	long-term potentiation
MADRS	Montgomery–Asberg Depression Rating Scale
MDD	major depressive disorder
MDE	major depressive episode
MGI	massage and gymnastic instrument
NAD	nothing abnormal detected
NE	norepinephrine
NO	nitric oxide
NRHM	National Health Rural Mission
OP	organophosphate
OPD	outpatient department
OS	oxidative stress
PA	physical activity
PFC	prefrontal cortex
PHQ	Patient Health Questionnaire
PIH	pregnancy-induced hypertension
PK	pancha karma
PMR	passive muscle relaxation
PMS	premental syndrome
PP	pulse pressure
PtMS	postmitochondrial supernatant
PTSD	posttraumatic stress disorder
PUFA	polyunsaturated fatty acid
Rb	retinoblastoma

RBC	red blood cells
RCT	randomized controlled trial
RKS	Rogi Kalyan Samitis
ROS	reactive oxygen species
RR	respiratory rate
RS	respiratory system
SBP	systolic blood pressure
SEM	scanning electron microscope
SF-36	short form 36
SNS	sympathetic nervous system
SOD	superoxide dismutase
SSRI	selective serotonin reuptake inhibitor
SVM	support vector machine
TCA	tricyclic antidepressant
TEM	transmission electron microscope
TM	transcendental meditation
TMS	transcranial magnetic stimulation
VAS	visual analogue scale

PREFACE

Holistic medicine aims to bring about optimal health by perceiving an individual as a composite of his/her physical, mental, psychological, emotional, social, and spiritual aspects. This branch of medicine involves detailed examination, diagnosis, and treatment of all these elements. Holistic medicine's combinatorial strategy will also help in alleviating the high levels of side effects and allergies brought about by the conventional medication regimes.

This book is a compilation of contributions from scientists, healthcare experts, and doctors working actively to bring about wholesome healing to every individual. The Sixth International Conference on Holistic Medicine, held on September 9, 2016, proved to be a great platform for experts specializing in traditional medicine, diabetes, yoga/body, mind/applied physiology, medicinal plants/herbal medicine, new developments in medicinal research and animal modeling, complementary/holistic medicine, homeopathy, meditation/spirituality/heath, and Unani/Tabiyat, which constitutes the cutting edge of holistic therapies. This book hopes to preserve the finest essence of the conference for generations to come. Here, chapters that deal with improving general health of people in various walks of life to treating some very challenging diseases have been included. Various schools of treatments, exercise regimes, and meditations are discussed in the following chapters. The chapters will shed light and hopefully help in spreading awareness and popularity of this wonderful and wholesome branch of medicine. We hope that this book will cater to the needs of researchers, pharmaceutical experts, and medical practitioners worldwide.

—The Editors

PART I
Yoga in Holistic Healthcare

CHAPTER 1

BENEFITS OF MEDITATION AND YOGA IN CLINICALLY DEPRESSED PATIENTS

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ABSTRACT

Approximately one in six individuals suffers from depression. The prevalence of depression appears to have increased over the past few decades. Several factors in the modern lifestyle significantly contribute to this rise. Many of these factors can potentially be modified, yet they receive little consideration in the treatment of depression. First-line management of depression primarily comprises psychotherapy and pharmacological treatment. For treatment-resistant patients, several invasive and noninvasive options are emerging. Empirical evidence is limited for most of these treatments. Yoga is the well-known modifier of lifestyle, but not yet fully explored and adopted in the management of depression. It constitutes a major element of upcoming "lifestyle medicine." Meditation and yoga are important components in this nexus between clinical treatments and public health promotion that involve the application of social, environmental, biological, somatic, and psychological principles to enhance physical and mental wellbeing. Large-scale adoption of yoga as a lifestyle may also

provide opportunities for general health promotion and potential prevention of depression. In this chapter, we provide a narrative discussion of causes, principles of management, and details of yoga as these relate to depression.

1.1 INTRODUCTION

Depression is a complex heterogeneous disorder comprising phenotypes with varying degrees of liability for affective, cognitive, neurovegetative, and psychomotor alterations. It is associated with an increased risk of developing chronic noncommunicable disease conditions such as diabetes mellitus, heart disease, and stroke.[1] In addition, patients with depression are almost 20-fold more likely to die by suicide than the general population.[2] According to new estimates by the World Health Organization, depression is the largest disability worldwide with the number of people living with depression increasing by over 18% between 2005 and 2015. Depression is twice as common in female as in men.[3] Depression has been estimated to have a prevalence in children of 2.5% and in adolescents of 4–8%.[4] There is a broad spectrum of depressive disorders (DDs) characterized by the presence of sad, empty, or irritable mood and varying degrees of other somatic and cognitive changes. According to the *American Diagnostic and Statistical Manual of Mental Disorders*, 5th edition,[5] disturbance of mood is the predominant feature of mood disorders. They are further divided into major DD (MDD), disruptive mood dysregulation disorder (for children aged up to 18 years), persistent DD (dysthymia; DD), premenstrual dysphoric disorder, substance-induced DD, DD due to another medical condition, as well as other and unspecified DD categories for subsyndromal cases that do not fulfill the criteria for MDD or DD. MDD is characterized by one or more major depressive episodes (MDEs)—a discrete period during which an individual experiences clear-cut changes in affect, cognition, and neurovegetative functions to a moderate degree for 2 weeks or longer with a diminution of their previous level of functioning. MDD is a highly prevalent disorder. The most recent global estimates of the prevalence were 16.2% for lifetime and 6.6% for the 12 months before the survey.[6]

1.2 CAUSES OF DEPRESSION

Dualistic theories separating mind and brain are being replaced with more integrated models that consider the biological, psychological, and social influences that produce depression. Kandel's understanding of mind–brain interactions provides a model for understanding the nature and possible causes of depression,[7] particularly:

- all mental processes derive from the brain;
- genes and their protein products determine neuronal connections and functioning;
- life experiences influence gene expression and psychosocial factors feed back to the brain;
- altered gene expression that produces changes in neuronal connections contributes to maintaining abnormalities of behavior;
- psychotherapy produces long-term behavior change by altering gene expression.

Therefore, both genetic and environmental factors are implicated in the etiology and treatment of depression.[8,9] Recent advances in the study of the genetic basis of depression have produced interesting findings, such as a functional polymorphism of the serotonin (5HT) transporter gene, which can be used to predict selective 5HT reuptake inhibitor (SSRI) response in the context of life stress.[10] Thus, depression can be understood to be the consequence of life stress interacting with heritable genetic and personality vulnerabilities that produce physiological and psychological dysfunction.

The prolonged exposure to stress produces characteristic alterations in brain neurotransmitter function often described as a "chemical imbalance."[11] This refers to alterations in the major chemical messenger systems responsible for neuronal transmission: 5HT, norepinephrine (NE), and dopamine. Depression has been associated with reductions in neurotransmission in these systems, and currently available antidepressant medications are thought to work by reversing these deficits. The alterations in these neuronal systems produce the characteristic psychological and somatic symptoms characteristic of depression. Recently, glutamate has been proposed as a mediator of neuronal and synaptic repair in emerging treatments for depression like ketamine.[12]

From among the other theories of the etiology of depression, one very interesting model has been proposed by Brown et al.[13] (Fig. 1.1), who describe mechanisms responsible for the onset, provocation, and perpetuation of depression. A "severe life event" can provoke the onset of an MDE. Proximal risk factors mediate the onset of the depressive episode, and distal risk factors both mediate the proximal risk factors and foster the perpetuation of a chronic illness course.

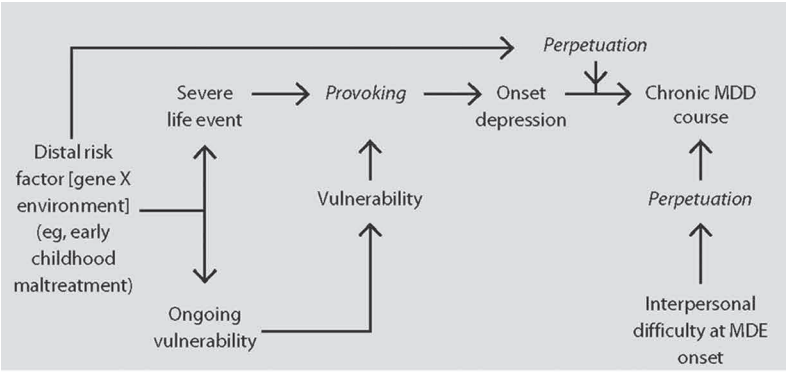

FIGURE 1.1 Modeling onset and course of depressive episodes. This model proposes mechanisms that are responsible for the onset, provocation, and perpetuation of depression. A "severe life event" can provoke the onset of a major depressive episode (MDE). Proximal risk factors (e.g., a poor-quality interpersonal relationship) mediate the onset of the depressive episode. Distal risk factors (e.g., early childhood maltreatment) both mediate the proximal risk factors (life events and ongoing vulnerabilities) and foster the perpetuation of a chronic illness course. MDD, major depressive disorder. Reproduced with permission from Brown et al., 2009.[13] ©Elsevier.

In addition, there are many medical diseases that commonly manifest with symptoms of depression, and many drugs can also produce depressive symptoms as adverse effects. Several other psychiatric diseases can also present with symptoms of depression, including schizophrenia, anxiety disorders, eating disorders, and substance abuse.

1.3 PRINCIPLES OF THERAPY

The essential principle in the effective treatment of depression is optimizing treatment on an individual basis. A variety of observer-rated and

self-report measures is available to assess both severity and outcome after treatment,[14,15] and some of the most common[16] are listed in Table 1.1.

TABLE 1.1 Commonly Used Outcome Measures.

Outcome	Measure	Comment
Observer rated		
Symptoms	Hamilton Depression Rating Scale (HDRS)	The HDRS has a greater emphasis on somatic symptoms compared with the MADRS. The CGI is a single overall assessment of illness severity
	Montgomery–Asberg Depression Rating Scale (MADRS)	
	Clinical Global Impression (CGI)	
Adverse effects (AEs)	Spontaneous report	Although categorization of AEs has been standardized, systematically elicited assessment is rare
Function	Global Assessment of Functioning (GAF)	GAF is a composite measure of symptom severity and function
Self-rated		
Symptoms	Beck Depression Inventory (BDI)	BDI is widely used and covers the range of depressive symptoms
	Hospital Anxiety and Depression Scale (HADS)	HADS includes anxiety assessment and omits somatic symptoms
	Patient Health Questionnaire (PHQ-9)	PHQ-9 rates how often depressive symptoms have been present rather than severity
Adverse effects	Global AE questionnaires not commonly used	Questionnaires for specific AEs are sometimes used (e.g., for sexual AEs)
Function	Medical Outcomes Study Short Form 36 (SF-36)	The SF-36 assesses functioning and health status
Quality of life	EuroQol 5D (EQ-5D)	A simple global health measure used in for health economic analyses

1.3.1 ALLOSTATIC LOAD

The complex processes in the brain identify and characterize what is stress. Stress response involves two-way communication between the brain and the cardiovascular, immune, metabolic, and other systems via the nervous system, endocrine system, and hypothalamic–pituitary–adrenal (HPA) axis. Homeostasis refers to the mechanisms that keep the parameters of an organism's internal milieu within the ranges necessary for survival. Maintaining a state of optimal homeostasis demands incurring the least possible long-term costs while an organism addresses the immediate needs. McEwen[17] (Fig. 1.2) proposes that allostasis is the adaptive process of maintaining stability during conditions that are outside of the usual homeostatic range. Allostatic load is the cost to the body for maintaining this stability during deviations from the usual homeostatic range, often reflected in pathophysiological conditions and disease progression. Physiologic systems activated by stress can both protect the body in the short term and damage the body in the long term, especially when stress becomes chronic and an allostatic load is incurred. For example, in response to a real or perceived threat, elevated blood pressure and heart rate due to increased sympathetic nervous system (SNS) activity is beneficial in the short term for survival. But a state of sustained high SNS activity, often due to sustained stress response, has diverse long-term effects with increased risk of cardiovascular and other chronic disorders.

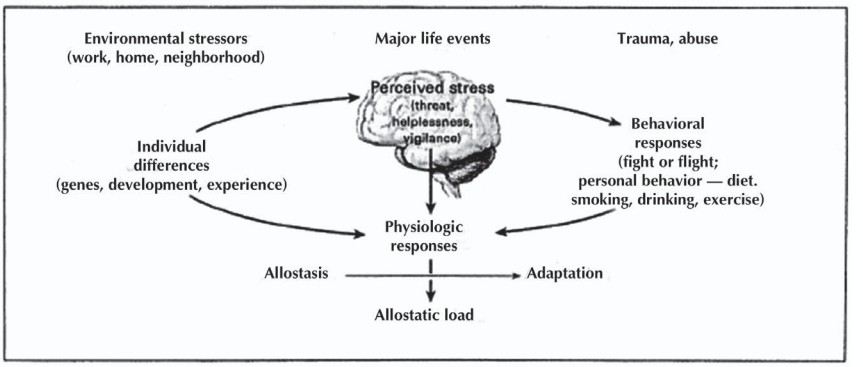

FIGURE 1.2 The stress response and development of allostatic load are illustrated. Reproduced with permission from McEwen © 2000 Nature Publishing Group.[17]

In stress, exacerbated disorders like depression, stress from psychological, physically external, and physically internal sources result in allostatic load. Various interventions for depression include pharmacotherapy; psychotherapy, physical therapy, and various mind–body therapies including yoga; and noninvasive and invasive surgical therapies. Ideal interventions reduce allostatic load and shift the regulatory systems toward optimal homeostasis.

1.4 MANAGEMENT OF DEPRESSION

In the management of depression options include, pharmacotherapy, psychotherapy, exercise, yoga, and other mind–body therapies, and several emerging treatments. Patient preferences and prior treatment history should always be taken into account. The commonly adopted stepped-care model proposes that the least intrusive, most effective intervention is provided first. If the initial intervention shows no benefit or if the individual declines an intervention, an appropriate intervention from the next step should be offered.

1.4.1 PHARMACOTHERAPY

1.4.1.1 MONOAMINE-BASED ANTIDEPRESSANT DRUGS

Narrow focus, over the last three decades, on increasing monoamine levels in the synaptic cleft (by blocking reuptake or degradation of monoamines) was overly simplistic. Monoaminergic neurotransmission is extremely complex and includes several neurotransmitters, presynaptic and postsynaptic receptors, transporters, and enzymes that determine the availability and the effects of the specific monoaminergic transmitter. The exact mechanism by which antidepressants exert their effects remains incompletely understood. Still pharmacologic modulation of monoamines is the first line of treatment and includes SSRIs and 5HT–noradrenaline reuptake inhibitors.

1.4.1.2 TOLERABILITY AND EFFICACY

All of the monoamine-based antidepressant drugs, regardless of their pharmacological class, have fundamentally modest efficacy, with response rates around 50%, and show a characteristic delayed (typically more than several weeks) response to treatment. In addition, they are associated with long-term adverse effects including weight gain, sexual dysfunction, and sleep disturbances.

1.4.2 PSYCHOTHERAPY

Psychotherapy for depression comes in many different forms. These different paradigms rely on different conceptual models and prescribe techniques that vary to some degree in their focus and methods. The most classical, cognitive–behavioral therapy teaches the patient with depression to identify negative, distorted thinking patterns that contribute to depression and provides skills to test and challenge these negative thoughts, replacing them with more accurate positive ones. Psychotherapy produces effects that are mostly equivalent to pharmacotherapy. Although it is clearly effective, many people have barriers to access, including time constraints, lack of available services, and cost.

1.4.3 PHYSICAL EXERCISE AND MIND–BODY THERAPIES

Exercise: Regular exercise is important for maintaining good physical and mental health.[18] Exercise is generally classified as aerobic (e.g., running or walking), resistance (e.g., weight training), or mindfulness based (e.g., yoga or qigong).

Yoga: Yoga is used in the treatment of depression in various contexts. Evidence is available that yoga can provide remission from depression in both naïve depression patients[19] and in depressed patients who are taking antidepressant medications but who are only in partial remission.[20]

1.4.4 COMPLEMENTARY AND INTEGRATIVE HEALTH TREATMENTS

Complementary and integrative health treatments have been used either alone or in combination with conventional therapies in patients with depression. They include

- dietary supplements (nutraceuticals)—*S*-adenosylmethionine,[21]
- herbs—St John's-wort, *Rhodiola rosea*, Saffron, and others,[22]
- folate,[23–25]
- acupuncture,
- omega-3 fatty acids, and
- hormones—dehydroepiandrosterone.

1.4.5 EMERGING TREATMENTS FOR DEPRESSION

1.4.5.1 ANTIDEPRESSANT DRUGS THAT ARE NOT MONOAMINE BASED

These are being developed to decrease untoward side-effects. Compounds that are under development include

- neurokinin-1 antagonists,
- glutamatergic system modulators,
- anti-inflammatory agents,
- opioid tone modulators and opioid-κ antagonists,
- hippocampal neurogenesis-stimulating treatments, and
- antiglucocorticoid therapies.

The degree of advancement in the development process varies across these different mechanisms, although all of these types of compounds have shown some degree of promise in the treatment of depression.

1.4.5.2 NOVEL PHARMACOLOGICAL APPROACHES

Novel approaches are being considered, which improve neuroplasticity and other biological mechanisms.

- Parenteral or intranasal administration of the glutamatergic drugs ketamine or esketamine, which are antagonists of *N*-methyl-d-aspartate.
- Intravenous scopolamine.
- The opioid modulator ALKS 5461.

Their efficacy is not well established yet for these treatments.

1.4.5.3 INVASIVE AND NONINVASIVE NEUROLOGICAL INTERVENTIONS

These treatments are commonly used in treatment resistant depression. They include

- electroconvulsive therapy,
- repetitive transcranial magnetic stimulation (TMS),
- deep TMS,
- transcranial direct current stimulation,
- low-field magnetic stimulation,
- vagus nerve stimulation, and
- deep brain stimulation.

They are providing new clues into biological mechanisms in depression and some of them may be used as first-line treatment in future.

1.4.6 COMBINED PHARMACOTHERAPY AND NONPHARMACOLOGICAL TREATMENTS

Several studies have shown that initiating treatment with both psychotherapy and pharmacotherapy produces significantly better outcomes than either treatment alone.

1.4.7 TECHNOLOGY-SUPPORTED CARE

Depression intervention technologies, which use computers, tablets, and phones to manage depression,[26] are effective at reducing symptoms of depression, when applied correctly. The rapid rate at which technology advances means that technology-based interventions will continue to grow and evolve rapidly. An emerging area of technology is digital phenotyping, which harnesses the growing availability of data generated continuously in the course of daily lives to create behavioral markers related to depression. Harnessing personal sensing platforms has the potential to shift our treatment tools from episodic to continuous, from reactive to proactive and from provider-centered to patient-centered.

1.5 SCIENTIFIC BASIS FOR THE BENEFITS OF YOGA

Yoga is one of the commonest forms of complementary and alternative medicine therapies, which is increasingly being practiced worldwide.[27] It is an ancient Indian practice based on the principles of mind–body medicine. The word "yoga" comes from the Sanskrit "yuj," meaning "yoke" or "union." Among the many forms of yoga, Rajyoga is commonly adopted in modern yoga-based interventions and is practiced through multiple steps, guided by Patanjali's Ashtanga (eight limbs) principles,[28] comprising of *yama* (moral codes, self-control), *niyama* (self-purification and process for maintaining morality), *asana* (posture), *pranayama* (breath control), *pratyahara* (governing sense), *dharana* (concentration), *dhyana* (meditation), and *samadhi* (supreme contemplation and meditation).

Yoga has been used to treat a variety of conditions including neurological and psychiatric disorders. Evidence emerging from the multiple studies on the beneficial effects of yoga on these diverse conditions suggests numerous mechanisms of its action. Effects of yoga in medical conditions like depression with overlapping pathophysiologies can be explained based on the principle that yoga practices reduce allostatic load in stress response systems and restore optimal homeostasis. Reduction in allostatic load, associated with pathogenesis of depression, by yoga can be understood by analyzing the effects at the level of modifications in pathophysiological processes. Despite advances in our understanding of the neurobiology of depression, currently no established mechanism can

explain all facets of the disease. Accordingly, we restrict our description of the mechanism of benefits of yoga to pathophysiological models of depression that are supported by findings from clinical studies. Yoga has both physical and mental components, and benefits from yoga are derived from the unique integration of changes in both mind and body.

Physical activity (PA) and exercise component of yoga: Modernity has formalized exercise undertaken by the average person and reduced the amount of work- and leisure-time PA. Our lifestyles are increasingly sedentary, with the resultant side-effect of lifestyle related chronic and complex medical conditions like depression and obesity, currently recognized as a major health problems worldwide. While adequate PA (based on clinical guidelines) is associated with fewer depressive symptoms, insufficient PA is a risk factor for DDs. Large systematic reviews suggest that exercise improves depression. Any form of PA is known to increase neuroplasticity in the brain.[29] PA in any form increases resilience to stress.[30] Exercise lowers cortisol, alters neurotransmitter function, and even promotes growth of the hippocampus, a phenomenon also seen after prolonged antidepressant use.[31] The positive impact of exercise on depression is mainly attributed to an increase in 5HT, NE, and endorphins in the brain. Numerous other studies support the benefits of moderate aerobic exercise on depression in various populations.[32,33] This risk factors may be best modified in early development, as regular PA since childhood reduces the risk of developing depression in adulthood. Yoga- and meditation-based lifestyle intervention is relatively safe and has been shown to provide a range of additional health benefits. Yoga also increases self-efficacy and self-esteem (via activity scheduling and attainment of goals) which are important psychological issues among people who are depressed.[34]

Meditation, mindfulness, and mental component of yoga: Meditative practices have an application in improving mood and preventing the tumescence of a depressive episode. A key aspect of meditation practice involves self-awareness (mindfulness), which arises through paying attention in the present moment, and nonjudgmentally. The use of meditation commonly involves both mindful awareness during yoga practice and mindfulness during everyday situations and social interactions, which may be relatively perceived as stressful. Meditative practices can be readily incorporated into people's lives and requires only basic training. Meditation regulates the emotional responses and improves the cognitive functioning by several mechanisms. Electroencephalographic studies have

revealed a significant increase in alpha and theta activity during meditation. Meditation has shown elevations in whole blood 5HT levels.[35] An increase in melatonin and decrease in cortisol have been associated with the meditative component of yoga.[36] Each of these factors contributes to maintain optimum homeostasis. For example, a rise in melatonin promotes circadian rhythms like sleep and improves mind–body communications by appropriately modifying immune system and stress response. Numerous studies have suggested that decreasing sustained levels of cortisol may decrease depression symtoms.[37,38]

Yoga and stress reduction: There is a cyclic relationship in neurological mechanisms involved in depression and stress responsivity. Therefore, there is a "kindling" effect in the chronic nature of depression, such that every episode of depression increases the likelihood of recurrence.[38] There is a strong link between stress and depression, and increased stress levels can significantly affect the severity of depression. Stress is considered to be one of the most significant predictors of health and depression is a leading contributor to global burden of disease and increased risk of mortality. Research indicates that yoga can reduce stress in depression and associated conditions[39] and is fundamental to treatment of depression.

Early-life adverse events and yoga in early life: The HPA axis is at the center of the comprehensive neurobiological model that seeks to explain the long-lasting consequences of stress. Early-life stress produces persistent increases in the activity of corticotropin-releasing hormone-containing neural circuits. Individuals who suffer from adverse life events in childhood show, as adults, a markedly enhanced activity of the HPA axis when exposed to stressors. Indeed, glucocorticoid receptor function is reduced in these individuals (so-called glucocorticoid resistance). These individuals also show increased activation of the inflammatory system, which is under physiological inhibitory control by cortisol. Indeed, glucocorticoid resistance, HPA axis hyperactivity and increased inflammation are all evident in depression. Practitioners of yoga show resilience to stress and don't show decreased levels of cortisol and inflammatory markers. Yoga interventions in depression have shown to decrease cortisol and inflammatory markers. Therefore, to decrease the impact of childhood adversity on the health and wellbeing of the individual and prevent depression in adulthood, yoga may be adopted from the earliest point of life possible.

Improvements in the markers of cellular aging: Stress and depression are associated with increased risk of other chronic medical illnesses, and

increased morbidity and mortality. This correlation between depression and aging-related illnesses suggests that depression may be related to accelerated cellular aging.[40,41] The connection between depression and accelerated cellular aging involve several pathways, including stress response and inflammation. For example, inflammation is linked to telomere shortening and the cytokines that are involved in intercellular signaling for the regulation of infection and injury may be responsible for this link. Inflammation causes oxidative stress, which in turn leads to DNA damage and telomere shortening.

Evidence indicates that yoga intervention can slow-down accelerated aging and may improve following biomarkers of cellular aging in both apparently healthy[42,43] and clinically depressed patients.[38]

a. Increase in telomere length and telomerase enzyme levels. Telomere length decreases due to aging, which is also seen in depression. Yoga reverses these changes.
b. Reduction in oxidative stress.
c. Reduction in inflammatory biomarkers like interleukin-6 (IL-6).
d. Reduction in stress induced markers like cortisol.

Improvements in the markers of neuroplasticity: Yoga has been shown to moderate a range of biological pathways including neuroplasticity. Yoga stimulates the central nervous system release of endorphins, monoamines, and brain-derived neurotrophic factor in the hippocampus.[34,42] Evidence from several imaging studies indicate that regular practice of meditation and yoga a wide range of effects like alterations in gray matter morphology, increased cortical thickness in the prefrontal cortex (PFC) and right anterior insula,[44] increased oxygenated hemoglobin in the anterior PFC.[45,46] These findings suggest that yoga can increase neuroplasticity and decrease neurodegeneration associated with MDD. Yoga can not only provide remission from clinical depression, it can help prevent relapses in remitted patients. Yoga can also help development and adaptations of the brain to make individual stress resilient and prevent development of depression.

1.6 OUTLOOK FOR THE FUTURE OF YOGA IN DEPRESSION