Etiology of Depressive Symptoms in Parkinson's Disease:

A Result of Neuroanatomical Deficiencies or a Consequence of the Psychosocial Stress of Parkinson's Disease Diagnosis

Submitted by

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We hereby recommend that the research project prepared under our supervision by Kara Joice entitled Etiology of depressive symptoms in Parkinson's Disease: A result of neuroanatomical deficiencies or a consequence of the psychosocial stress of PD diagnosis will be accepted as partial fulfillment for the degree of Master of Physician Assistant.

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Abstract

Introduction: Parkinson's disease (PD) affects approximately 1 million individuals in the US. Depressive symptoms occur in approximately half of PD patients and are a significant cause of functional impairment. Methodology: A computer-based search of the literature, augmented by extensive bibliography-guided article reviews, was utilized to find data on depression and Parkinson's disease. Twenty articles were reviewed using evidence-based methods. Reviewed topics include PD, depression, neurodegeneration in PD patients, onset of depression in PD, and treatment of depression in PD patients. Results: Postmortem and imaging studies have correlated clinical symptoms of depression with the non-motor basal ganglia-thalamic-frontal cortex circuit. PD patients with comorbid depression have smaller subcortical nuclei which is similar to non-PD patients with depression. Changes in both the serotonin and dopamine systems have been implicated in depression. Decreased numbers of serotonin neurons in the dorsal raphe nucleus and dopamine neurons in the ventral tegmental area are found postmortem in PD patients with a history of depression. Conclusion: There is accumulating evidence suggesting that depression in PD is secondary to the underlying neuroanatomical degeneration, as well as a reaction to the psychosocial stress and disability of the PD diagnosis.

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Acknowledgements

First and foremost, I would like to give a special thanks to my family; Charles, Jane, Robb, Kelly, Katie, Richard, Steve, Adam, Connor, Brenna and the two on the way. Without their encouragement and faith, my personal accomplishments would not have been a possibility. I would like to dedicate the completion of this thesis to my grandfather, "Best Friend", who will be missed, loved, and remembered always.

Introduction

In the United States, an estimated 500,000 people are thought to suffer from Parkinson's disease (PD), with about 50,000 new cases reported annually.[1] Parkinson's disease is a progressive neurological disorder affecting the area of the brain that influences muscle movement. Patients consequently experience the four characteristic motor impairments of PD: rigidity or stiffness of arms, legs or neck; resting tremor, usually of the hands causing a back-and-forth "pin rolling" of the thumb and middle finger; bradykinesia or slowness and reduction of movement, progressing to a slow, shuffling walk, unsteady gait, stooped posture, and freezing of the muscles affecting daily activities in later stages of the disease; and rigidity, or muscle stiffness, also referred to as "cog wheeling", due to the fact that the size of the movements are decreased and jolted.

Dopamine is a neurotransmitter that conveys signals causing muscles to formulate smooth, controlled movements. In Parkinson's disease patients, the neurons in the substantia nigra that are responsible for release of this chemical are impaired. Dopamine-producing nerve cells naturally deplete with age, nonetheless patients with PD are without more than half of these required cells, producing the motor symptoms attributed to this disease.

Depressive disorders affect over 18 million people in the United States and is the leading cause of disability in the US and worldwide.[2] Requirements for diagnosis of depression according to the *Diagnostic and Statistical Manuel of Mental Disorders*, fourth edition (DSM-IV), require the patient to be subjected to five of the succeeding nine criteria for at least two weeks: depressed or irritable nearly every day for most of the day; markedly diminished interest or pleasure in previously enjoyed activities; weight

loss or weight gain; changes in sleep pattern; psychomotor agitation or retardation; fatigue or loss of energy; feelings of worthlessness or excessive or inappropriate guilt; indecisiveness or diminished ability to concentrate; and recurrent thoughts of death.[3]

The foundation for depression is multi-factorial. A biological vulnerability towards depression can be inherited as shown in twin studies and family history. A psychological predisposition is also evident with depression occurring at a higher prevalence in individuals with low self-esteem. Lastly, physical changes in the body, such as medical illnesses, affect the body and mind adversely, thereby increasing the frequency of depression in these individuals as well.

Literature Review

The findings in this literature review demonstrate that the diagnosis of PD, a progressive incurable disorder, is a powerful cause of despair for the patient. Activities of daily living such as walking, eating, and talking are all, in time, negatively affected and many, in the later stages of the disease, are eventually infeasible for the PD patient. The course of this disease is a long one, with pharmacological agents less able to control the physical manifestations of the disease in its later stages. Initial treatment demonstrates optimistic outcomes for the patient physically, however as the disease progresses, the characteristic traits of PD (tremor of the hands, limbs, jaw, and face, rigidity or stiffness of the limbs and trunk, bradykinesia or slowness of movement, and postural instability or impaired balance and coordination), become a battle that the patient is unable to overcome. Research on the occurrence of depression during the course of PD was seen to be greatest at three stages; the period of initial diagnosis, the period of decrease in independence, and the rapid decline and worsening of symptoms.[4] The

beginnings of the disease (the initial diagnosis) and its later advancement (total dependence) have a substantial impact with respect to depressive episodes.

Alternatively, a biological basis linking PD and depression implicated common areas of neurological involvement. Depression in PD is the result of the neurodegenerative process characterized by deterioration of the subcortical nuclei, some of which have also been implicated in depression.[5] PD patients with co-morbid depression have smaller subcortical nuclei which is similar to non-PD patients with depression.[6] Changes in the brain chemical messengers are thought to be the key neurochemical mechanism behind depression and PD. Changes in both the serotonin and dopamine systems have been implicated in depression. Decreased numbers of serotonin neurons in the dorsal raphe nucleus and dopamine neurons in the ventral tegmental area are found postmortem in PD patients with a history of depression.[7] Evidence from transcranial sonography studies of depression suggest a pathophysiological role of a variation of ascending and descending pathways in the brainstem with a consecutive imbalance of neurotransmission. These similar findings in unipolar depression and depression in Parkinson's disease indicate that alteration in the basal limbic system may be a common pathway in the pathogenesis of depressive illness.[8]

Purpose of Study

The co-morbidity of Parkinson's disease and depression is a common finding that affects more than half of patients who are diagnosed with PD. With increasing age of the population and growth of the number of elderly individuals, a substantial increase in PD can be anticipated. This changing demographic creates a scientific imperative to better understand the causes of Parkinson's and its co-morbid disease, depression.

Unfortunately, depression in PD patients is under diagnosed and rarely treated therefore, the adverse affects of depression effect the quality of the patient's life.[9, 10]

This study looked at the etiology of depressive symptoms in Parkinson's disease, specifically whether or not this state of depression is a result of neuroanatomical deficiencies or psychosocial stress secondary to the diagnosis of a chronic disease. Treatment of depression in Parkinson's patients has been shown to be favorable to the patient, family and even the course of the disease, therefore, determining the onset and establishing a treatment plan for depression promptly would improve the patient's quality of life.

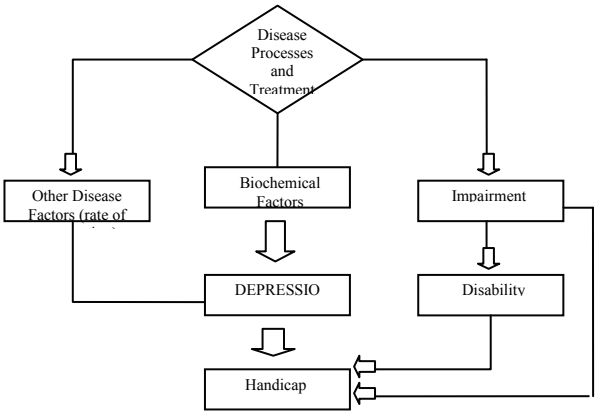
Methodology

To evaluate the link between the co-morbidity of Parkinson's disease and depression a systematic review of the literature was undertaken. The investigation utilized the Medline database and included articles from 1970 to the present. Twenty articles were reviewed using evidence-based methods. Articles included for review incorporated Parkinson's disease and depression. Variables examined consisted of neurodegeneration that occurs in PD patients, neurotransmitters involved in PD as well as depression, psychosocial stressors of a chronic illness diagnosis, and the onset of depression relative to the diagnosis of PD. Articles were chosen for analysis based on the journal's reputation, the study type (randomized controlled trials and literary reviews) and the inclusion of relevant material considered necessary to address the premise being examined.

Results

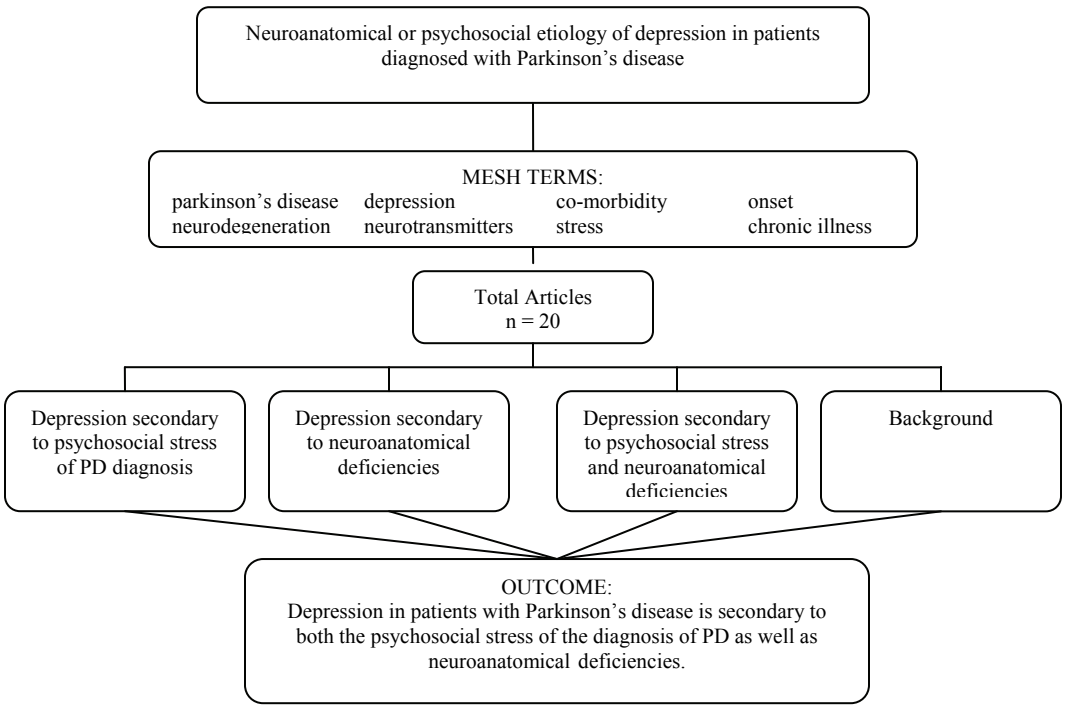
Research supports the idea of both neuroanatomical deficiencies as well as psychosocial stress secondary to the diagnosis of a chronic disease as factors affecting the etiology of depression in PD individuals. Although mutual biological connections, in the form of altered states of neurotransmitters, along with common areas of neurological involvement, are evident in both disorders, the psychosocial stress factor is shown to be a subjective ingredient affecting the etiology of depression.

Figure 1. Suggested Model for the multi-factorial causes of depression in patients with Parkinson's disease



Of the twenty articles that were examined, twelve were shown to support a dual etiology of depression in Parkinson's disease patients, two demonstrated a psychosocial background, two established a neurodegenerative nature, and three were utilized for background information.

Figure 2. Literary Review Flow Sheet



Discussion

Evidence in Literature

In 2003, McDonald et al published an article supporting the idea of depression as having a biological and psychological etiology. In this article depression is viewed as reactive, in that a diagnosis of Parkinson's disease requires adjustment for both patient and family. Patients must cope with the physical disability associated with the progression of the disease in addition to the possibility of an illness that may ultimately result in loss of employment, marital conflicts, as well as alienation due to physical disability associated with the symptoms of Parkinson's disease. Palliative care that tends to be less effective with time, rather than treatment and resolution of an underlying factor,

is common for Parkinson's disease patients, thereby building the foundation for the psychological stress factor associated with the diagnosis of Parkinson's disease.[11]

Depression was also shown to be a result of the neurodegeneration in Parkinson's disease according to McDonald's research. Parkinson's disease is characterized by degeneration of the subcortical nuclei. This neurodegeneration is also noted in patients with depressive disorder. Postmortem imaging studies show that Parkinson's disease patients with comorbid depression have smaller subcortical nuclei, which is similar to non-PD patients with depression.[11] Both Parkinson's disease and depression are linked to a degeneration of neurotransmitters. Changes in both serotonin and dopamine arrangement is implicated in depression.[5, 11] Similar changes in the neurotransmitter dopamine are known to cause changes associated with Parkinson's disease.

D.J. Burn summarizes the frequency of depression in PD and its etiology. Burn concluded in his studies that depression in Parkinson's disease was common, yet under diagnosed, therefore having a major negative impact upon the patient and quality of life. Burn's research stated that depression in Parkinson's disease is almost certainly multi-factorial, representing a mixture of psychological and neurochemical substrates.[12] Both McDonald and Burn's research suggest a dual etiology of depression in Parkinson's patients supporting both psychological and physiological factors.

Poewe et al showed two discernable peaks in the occurrence of depression in Parkinson's disease patients. The first occurs early in the course of the disease with a second peak occurring with progression of the disease.[6] This pattern of depression in PD patients suggests a psychological factor attributed to the initial diagnosis of PD as a chronic disease and during the state of dependence of the patient as the disease

progresses. This study suggests, that in the PD patient population, the stress which occurs at specific stages of Parkinson's disease reinforces a psychological basis of this co-morbid occurrence.

A study done by Fukumishi et al looked at 19 Parkinson's disease patients with an associated depressive state, 10 PD patients without depression and 10 patients with depression only. Evaluation of these groups in the study showed that social dysfunction and severe depression was significantly higher in the group of PD patients with depression than with patients suffering from depression alone.[5]

Two articles suggested that patients with an early onset of Parkinson's disease, that is, at an earlier age than the average age of onset of the disease, had a significantly higher frequency of major depression than the patients with late onset Parkinson's disease.[13, 14] Activities of daily living and relationships were adversely affected at a younger age, accompanied by a consequential state of depression.

The etiology of depression in Parkinson's disease is an important issue of research due to the physiological and psychological impact on the patient. Treatment of depressive disorders in Parkinson's disease patients is shown to correlate with slower progression of both diseases' overlapping symptoms. Depression that is diagnosed early in the course of the disease can be treated successfully with medication, thereby improving the quality of life for the patient and the patient's family.

Research on the etiology of depressive symptoms in Parkinson's disease patients had a tendency to support the idea of both a neuroanatomical as well as a psychosocial basis. Neurotransmitters and post mortem studies were similar in both disorders,

however the etiology of depression due to the diagnosis of a chronic disease and the associated stress that undoubtedly accompanies this diagnosis, could not be ruled out.[15-20]

Weaknesses in the Literature

A flaw in the literature was found in studies that assessed the incidence of depression in a random group of individuals. Individuals in these groups, because of family history or gender, could have a higher incidence of depression, thus weakening the literature.

Another problem arose when determining the degree of physical impairment in each subject. Depression, according to the literature in this study, had a positive correlation with the extent of physical disability the Parkinson's patient experienced. Therefore, the patients suffering from more severe motor impairment were more likely to have the co-morbid depressive disorder.

Gaps in the Literature

Limitations in reviewing articles for research affect the validity of the article. In this project, problems in the reviews include inaccurate definitions of depression. Depending on the article, depression was referred to as dysthymic disorder, major depressive and minor depressive episodes. Articles also used a variety of different scales and diagnostic criteria to determine the degree of cognitive impairment in Parkinson's disease as well as patients diagnosed with depression.

Additional limitations in this review include no assessment of drug treatment and its efficacy and prospective follow-up data not available. Also, life experiences that could affect depressive episodes were not evaluated for patients in these studies thereby making the diagnosis of depression and its etiology difficult to assess. Finally, due to the

overlap of symptoms in the two disease states, depression was difficult to diagnose accurately.

Validity of the review

Articles were reviewed in a systematic fashion, accumulating the original articles via Medline with the above cited key words. Articles were examined to determine if all criteria were met for inclusion in the study.

Weaknesses in the review

This paper was a systematic review of the literature to determine the etiology of depressive symptoms in patients diagnosed with Parkinson's disease. The results that were reported are that of the authors, therefore affecting the internal validity of the articles reviewed. Journal names and authors were not selected at random by the author and advisor of the patient thereby allowing for biased results in this review.

Conclusion

Twenty articles were examined and incorporated in this literary review. Twelve articles met the criteria for Level I randomized controlled trials. The supplementary articles meet the criteria for Level II and Level III verification. In accordance with the Level I criteria reviewed, a Grade A recommendation for a dual etiology behind the co-morbidity involving the disease states of Parkinson's and depression is recommended. The Parkinson's disease patient population is biologically affected by an underlying physiological degeneration. This, paired with the fact that PD is a physically impeding illness, thus adding stress and despair to the diagnosed individual, readily explain the frequent occurrence of depression as a concurrent state.[8, Fig.1]

References

1. Cummings, J. Understanding Parkinson Disease. The Journal of American Medical Association. 1999: 281(4); 376-378.

2. Robins L, Regier DA. Psychiatric *Disorders in America, The Epidemiologic Catchment Area Study*. 1990: New York: The Free Press.

3. DSM-IV

4. Tom T, Cummings J. *Depression in Parkinson's Disease*. Drugs & Aging. 1998: 12(1); 55-74.

5. Fukunishi I, Hosokawa K, Ozaki S. *Depression Antedating the Onset of Parkinson's Disease*. The Japanese Journal of Psychiatry and Neurology. 1991; 7-11.

6. Poewe W, Luginger E. *Depression in Parkinson's disease; impediments to recognition and treatment options*. Neurology. 1999: 52(7); S2-6.

7. Blandini F, Nappi G, Tassorelli C, Martignoni E. *Functional changes of the basal Ganglia circuitry in Parkinson's disease*. Prog Neurobiol. 2000: 62; 63-88

8. Lisanby S, McDonald W, Massey E, Doraiswamy P, Rozear M, Boyko O. *Diminished subcortical nuclei volumes in Parkinson's disease by MR imaging*. J Neural Transm Suppl. 1993: 40; 13-21

9. Liu C, Wang S, Fuh J, Lim C, Yang Y, Liu H. *The correlation of depression with functional ability in Parkinson's disease*. J Neurol 1997: 244; 493-498.

10. Hobson P, Holden A, Meara J. *Measuring the impact of Parkinson's disease with the Parkinson's Disease Quality of Life questionnaire*. Age Ageing. 1999: 28; 341-346.

11. McDonald W, Richard I, and DeLong M. *Prevalence, Etiology, and Treatment of Depression in Parkinson's Disease*. Society of Biological Psychiatry. 2003: 54; 363-375.

12. Burn DJ. *Depression in Parkinson's disease*. European Journal of Neurology. 2002: 9; 44-54.

13. Kostic V, Filipovic S, Momeilovic D, Sokie D, Sternic N. *Effect of age at onset on frequency of depression in Parkinson's disease*. Journal of Neurology, Neurosurgery, and Psuchiatry. 1994: 10; 1265-7.

14. Giladi N, Treves T, Paleacu D, Shabtai H, Orlov Y, Kandinov B, Simon E, and Korezyn A. *Risk Factors for dementia, depression, and psychosis in long-standing Parkinson's disease*. Journal of Neural Transmission. 2000: 107; 59-71.

15. Leentjens, Verhey F. *Markers for depression in Parkinson's disease*. ACTA Psychiatrica Scandinavica. 2002: 106; 196-201.

16. Silver J, Yudofsky S. *Drug treatment of depression in Parkinson's disease. Parkinson's disease*. Neurobehavioral aspects. 1992: 240-254.

17. Becker T, Becker G, et al. *Parkinson's disease and depression: evidence for an alteration of the basal limbic system detected by transcranial sonography*. Neurol Neurosurg Psychiatry. 1997: 63; 590-595.

18. Brown R, Jahanshahi M. *Depression in Parkinson's Disease: A Psychosocial Viewpoint*. Behavioral Neurology of Movement Disorders. 1995: 65; 61-84.

19. Rojo A, Aguilar M, Garolera M, Cubo E, Navas I, Quintana S. *Depression in Parkinson's disease: clinical correlates and oucome*. Parkinsonism and Related Disorders. 2003: 10; 23-28.

20. Mayeux R. The “serotonin hypothesis” for depression in Parkinson’s disease. Adv Neurol 53: 163-166.

Appendix A
Raw Data

Study (year)	**Research Addresses** 1. Prevalence of PD and depression 2. Depression is "reactive" and secondary to the psycholsocial stress of a chronic disease and the associated disability 3. Depression results from neuroanatomical changes that occur in PD	**Title** Type of evidence 1. Randomized control 2. Longitudinal 3. Lit Review 4. Retrospective	**Study Population**	**Findings**	**Supportive of research** 1. Neuroanatomical Deficiency 2. Psychosocial 3. BOTH A. Background
#1 1999	Review of Parkinson's disease	*Understanding Parkinson's disease*	N/A	• half a million Americans are affected by PD • Average age of onset 50-60 • Increase in PD anticipated	A
#2 2000	Review of Depression	Depression	N/A	• depressive d/o involves the body, mood, and thoughts • different types of depression (MDD, dysthymia) • symptoms of depression • causes of depression (biological vulnerability inherited, stress, medical illnesses) • higher incidence of depression in women	A

#3 1995	Diagnostic criteria of depression according to the DSM-IV	Diagnostic and statistical manual of mental disorders. 4th ed., primary care	N/A	• Requirements for diagnosis of depression require the patient to be subjected to five of the succeeding nine criteria for at least two weeks: depressed or irritable nearly every day for most of the day; markedly diminished interest or pleasure in previously enjoyed activities; weight loss or weight gain; changes in sleep pattern; psychomotor agitation or retardation; fatigue or loss of energy; feelings of worthlessness or excessive or inappropriate guilt; indecisiveness or diminished ability to concentrate; and recurrent thoughts of death	A
#4 1998	1, 2, 3	Depression in Parkinson's Disease: Pharmacological Characteristics and Treatment 2	Patients with major depression and PD	• Manifestations in PD result from idiopathic degeneration of dopamine in substantia nigra • Course of illness in PD is long • Treatment of depression in pts with PD may significantly slow cognitive decline, ADL, and progression to more advanced stages • Pts with MDD and PD had significantly longer duration of illness and worsened to a significantly greater extent • Levels of dopamine, serotonin	3

				noradrenaline and acetylcholine decreased in pts with PD. Depression associated with deficiencies of the first 3.	
#5 1991	1, 3	Depression Antedating the Onset of Parkinson's Disease 1	19 pts with idiopathic PD associated with a depressive state. 1) More than 3 years of neurological sx, 2) depressive state fulfilled the diagnostic criteria in DSM 3) drug induced depression excluded, 4) >2 neuropsuchiatrists agreed on all criteria.	• Social dysfxn and severe depression, in PD pts in which the depressive state preceded neuro sx, was significantly higher.	1
#6 1999	1, 2, 3	Depression in Parkinson's disease: Impediments to recognition and treatment options 1	Frequency of depression over various stages of PD	• Two discernable peaks of depression in PD pts. 1st occurs rather early in mild disease and then drops. The second occurs as late-onset pathology.	3

#7 2000	1, 3	Functional changes of the basal Ganglia circuitry in Parkinson's disease. 3	N/A	• The degeneration of dopamine-containing neurons of the substantia nigra pars compacta triggers a cascade of fxnal changes, which leads to a significant rearrangement of the basal ganglia fxnal (responsible for the motor system of the body) organization.	1
#8 1993	1, 3	Diminished subcortical nuclei volumes in Parkinson's disease by MR imaging 3	N/A	• MR results show a decrease in the nuclei located in subcortical nuclei in Parkinson's disease patients	1
#9 1997	1, 2, 3	The correlation of depression with functional ability in Parkinson's disease 1	Study looking at the functional ability in PD pts with and without depression	• Patients with PD and depression showed an increase in functional impairment than did patients who suffered from depression or PD alone.	3

#10 1999	1, 2, 3	Measuring the impact of Parkinson's disease with the Parkinson's Disease Quality of Life questionnaire 1	Patients with the diagnosis of depression were evaluated for impact of the disease.	• Patients with PD reported more depressive symptoms than control groups • PD patients quality of life was reported as less than that of control non-PD patients	3
#11 2003	1, 2, 3	*Prevalence, Etiology, and Treatment of Depression in Parkinson's Disease* *3*	N/A	• Depression occurs in approximately half of PD patient • Depression increases both motor and cognitive disability • Depression is the primary source of both patient and caregiver distress • Symptoms of PC overlap with the symptoms of depression. Patients with advanced PD often have significant sleep disturbance, fatigue, psychomotor slowing, difficulty concentrating, and diminished sexual function. • PD pts have more depressive sx than pts with other chronic disabling diseases. • PD pts with comorbid depression have smaller subcortical nuclei, which is similar to non-PD pts with depression	3

#12 2002	1, 2, 3	Depression in Parkinson's disease 1	18 patients with PD were examined on fluctuations of mood.	• Depression in PD is a common and under-recognized complication, with a major impact upon pt and quality of life. • Depression may precede the onset of PD by a number of years. • The etiology of depression in PD is multifactorial.	3
#13 1994	1, 2, 3	Effect of age at onset on frequency of depression in Parkinson's disease 1	169 pts with diagnosis of PD were divided into two groups: those with an age of onset less than or equal to 50 and the second with an onset greater than 50. The incidence of depression was evaluated in these two groups.	• Results showed a significantly higher incidence of depression in early onset PD. • Pts with an early onset of the disease had a significantly higher frequency of mj depression than the pts with late onset PD • Pts with PD associated with depression were generally younger than non-depressed pts. • Results suggest that depression may be related to impairment of ADL.	3
#14 2000	1, 2, 3	Risk factors for dementia, depression and psychosis in long-standing Parkinson's disease 1	172 PD patients were evaluated for the association of co-morbid disorders with other clinical features of PD, including disease stage and age of symptom onset. To study the relationships b/t clinical features of PD and the development of dementia, depression or psychosis in pts with long-standing PD.	• Depression was associated with younger age of sx onset as well as a higher stage of H&Y. • Depression appears during the 1st year of PD sx and higher depression rates were reported in stages I and IV of H&Y. • Depression is the single most important risk factor for impaired cognitive function in PD.	3

#15 2002	1, 2, 3	Markers for depression in Parkinson's disease 1	To assess whether general risk factors for depression are also markers of depression in pts with PD and to identify additional markers. data from 161 PD patients, 40 of whom suffered from MDD.	• Five risk factors (age, sex, prior hx of depression, a positive family hx of depression and the presence of comorbid somatic disorders) increased the prevalence of depression in PD pts.	3
#16 1992	1, 2, 3	Drug treatment of depression in Parkinson's disease. Parkinson's disease 1	PD patients were assessed when depression was treated medically versus no treatmen	• PD patients who had drug treatment for depressive symptoms were shown to have better outcome	3
#17 1997	1, 2, 3	Parkinson's disease and depression: evidence for an alteration of the basal limbic system detected by transcranial sonography 1	Patients with PD and pts with PD and depression were assessed with sonography for alterations of the basal limbic system	• PD patients with depression showed similar changes in the basal limbic system as did patients with depression only	3

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