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Journal of Cancer Prevention & Current Research

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Unraveling the complex relationship between anemia and Parkinson's disease: study on disease burden and comorbidities

Abstract

Background: Several studies have suggested a greater prevalence of Parkinson's disease in individuals with anemia. This relationship is particularly noteworthy due to the association between Parkinson's disease, increased frailty, and malnutrition. It is imperative that further research be conducted into the interplay and consequences of these factors for patients with both conditions, in order to comprehend the potential negative outcomes that may arise from their coexistence. To investigate the impact of Parkinson's disease on resource utilization and disease burden in patients with concurrent anemia, we analyzed individuals admitted to the hospital with anemia and PD.

Material and Methods: The National Inpatient Sample (NIS) data for the years 2019-2020 was utilized, and International Classification of Diseases (ICD) codes were employed to identify patients who were admitted with a primary diagnosis of anemia and had a secondary diagnosis of Parkinson disease. The primary and secondary outcomes were determined after adjusting for potential confounding variables through the use of multivariate regression analysis.

Results: The hospitalization data of 316,395 patients with a primary diagnosis of anemia was analyzed. Of these, 3,704 patients (1.1%) had a secondary diagnosis of Parkinson's disease. It was observed that Parkinson disease was not an independent predictor of mortality but it was associated with slight increase in the length of stay 3.84 days (95% CI 3.29-3.41) vs 3.35 days (95% CI 3.29-3.41, P=0.003). No difference was noted in total cost of hospitalization (USD 43265, 95% CI 41913-44617) vs (USD 43650, 95% CI 40322- 46977, P=0.815). Patients with Parkinson's disease were found to have higher odds of developing constipation (OR 1.54, 95% CI 1.22-1.94, P<0.001), malnutrition (OR 1.25, 95% CI 0.98-1.61, P=0.007), frailty (OR 2.88, 95% CI 2.47-3.36, P<0.001), pneumonia (OR 1.14, 95% CI 1.11-1.69, P=0.002), and requiring palliative care involvement (OR 1.88, 95% CI 1.36-2.59, P<0.001). However, patients with Parkinson's disease were less likely to experience major bleeding episodes (OR 0.80, 95% CI 0.66-0.96, P=0.019), and there was no significant difference in the incidence of minor bleeding (OR 5.31, 95% CI 0.67-42.10, P=0.114) or blood transfusion instances (OR 1.00, 95% CI 0.85-1.16, P=0.984).

Conclusion: The data suggests that Parkinson's disease was not found to be an independent predictor of mortality. However, it was observed to be associated with a decrease in the occurrence of major bleeding episodes. Additionally, it was associated with a slight increase in length of stay and an increased risk of malnutrition, frailty, constipation, pneumonia, and involvement of palliative care. Effective management of Parkinson's disease may lead to a decrease in the occurrence of these debilitating events, which can negatively impact the quality of life. Additional prospective studies are needed to confirm the results of our retrospective analysis.

Volume 15 Issue 1 - 2024

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Received: December 25, 2023 | **Published:** January 03, 2024

Introduction

Parkinson's disease (PD) is a progressive neurological disorder marked by motor and non-motor symptoms that significantly affect patients' quality of life. Recent data indicate that PD is experiencing the most rapid increase in prevalence among neurological disorders, emerging as a leading global cause of disability (GBD). As PD continues to impact more lives worldwide, comprehending its extensive effects, particularly on concurrent conditions like anemia, is pivotal for holistic patient care.[1]

Anemia, prevalent especially among the elderly, is linked to various chronic conditions, including PD.[2,3] Despite this association, the intricate dynamics between PD and anemia and their collective influence on disease burden are not well understood. With the World Health Organization (WHO) projecting the population aged over 60 to double by 2050, there is an urgent need to refine treatment strategies and understand how comorbidities affect this rapidly growing demographic, which is also the most vulnerable to disease and disability.[4] Recent studies underscore this urgency, revealing an increase in anemia prevalence with age and its association with higher hospitalization rates.[5,6] Moreover, the United States records nearly 90,000 PD diagnoses annually, predominantly in individuals over 65 years of age, a demographic also showing a rising incidence of PD.[7,8] The observed dysregulation of iron metabolism in anemic patients, leading to oxidative stress and cellular death, further emphasizes the potential link and pathophysiology related to reduced iron levels in the substantia nigra of those with PD.

This retrospective study delves into the bidirectional relationship between PD and anemia. Its primary goal is to pinpoint key variables that will inform targeted interventions, ultimately aiming to mitigate

the overall disease burden and substantially improve the quality of life for those affected.Through an examination of inpatient data from individuals with primary and secondary diagnoses of anemia and Parkinson's disease (PD), respectively, this study aims to quantify the impact of PD on various disease burden indicators, including hospitalization rates, symptom severity, and mortality rates. This research constitutes a critical step towards elucidating the intricate consequences of PD on patients who simultaneously grapple with anemia.

Methods and materials

Data design and source

This research was based on the extensive National Inpatient Sample (NIS), which spans the years 2019-2020 and serves as a robust repository encompassing inpatient care details from a broad spectrum of healthcare facilities in the United States. With data aggregated from over 21 million hospital admissions annually and including information from 46 states and the District of Columbia, the NIS offers an impressive representation covering approximately 98% of the U.S. population. It's important to note that entries related to rehabilitation and federal institutions like Veterans Affairs hospitals are excluded from this comprehensive compilation. Administered by the Agency for Healthcare Research and Quality through its Healthcare Costs and Utilization Project, the NIS provides an exceptionally large sample size conducive for conducting in-depth analyses of various healthcare phenomena, even those associated with rare diseases.

Study population

Our research entailed a comprehensive analysis of discharge data sourced from the National Inpatient Sample (NIS) database for adults aged 18 and above who had been diagnosed with anemia. The International Classification of Diseases, Tenth Revision, Clinical Modification/Procedure Coding System (ICD-10-CM/PCS) was employed as the coding scheme for this investigation. Subsequently, we meticulously classified the patients into those with and without Parkinson's disease.

Study variables and outcomes

The study aimed to compare the effects of Parkinson's disease on outcomes in hospitalized patients diagnosed with anemia. The primary endpoint was inpatient mortality rates among patients with anemia with and without Parkinson's disease. The secondary outcomes included length of stay, total cost of hospitalization, odds of developing constipation, malnutrition, frailty, pneumonia, and requiring palliative care involvement.

Statistical analysis

The representation of categorical data was through percentage; on the other hand, mean values and standard deviations were used to characterize continuous variables. To compare categorical variables among different groups, Pearson's chi-square test or Fisher's exact test was employed, whereas the student's t-test was used to evaluate continuous variables. Both univariate and multivariate analyses were performed to determine the associations between Parkinson's disease and key parameters, such as in-hospital mortality, prolonged length of stay, total treatment cost, and adverse outcomes. The Stata 17 software (College Station, TX, USA) was utilized to conduct all statistical analyses, which provided valuable insights that significantly contributed to answering research questions and hypotheses, ultimately enhancing the overall quality of the study.

Results

The mean age of patients with anemia and Parkinson's disease was (78.4 +/- 8.72 years), which was significantly higher than the mean age of patients without Parkinson's disease (64.62 +/- 19.32 years, $P < 0.001$). The gender distribution of patients with anemia and Parkinson's disease was similar (49.39% males vs. 50.61% females, $P < 0.001$), whereas patients without Parkinson's disease had a higher proportion of females than males (62.49% females vs. 37.51% males, $P < 0.001$). The prevalence of Parkinson's disease was lower in patients from low-income groups ($1-$49,999 = 26.39% vs. 33.92% & 50,000-$64,999 = 24.63% vs. 26.22%) compared to those from high-income groups ($65,000-$85,999 =25.58% vs 22.65% & >$86,000= 23.4 vs 17.21, $P < 0.001$). Medicare patients had a higher prevalence of Parkinson's disease (91.9% vs. 61.98%, P<0.001), while patients with Medicaid (2.47% vs 14.14), private insurance (5.22% vs 18.6%) and no insurance (0.41% vs. 5.29%) had fewer patients with Parkinson's disease ($P < 0.001$). Patients with anemia and Parkinson's disease had a higher prevalence of chronic conditions such as hypertension (35.49% vs. 31.4%, P=0.016), diabetes mellitus (27.4% vs. 24.12%, P =0.035), hyperlipidemia (49.8% vs 35.81%, P<0.001), and fluid and electrolyte disorders (27.94% vs 24.74%, $P < 0.001$). A greater proportion of patients with Parkinson's disease were discharged to skilled nursing facilities (4.06% vs. 2.27%, P<0.001) and homes with home health care (37.95% vs 17.42%, P<0.001), while a greater proportion of anemia patients without Parkinson's disease were discharged home (77.4% vs 57.52%, $P < 0.001$) (Table 1).

After conducting a multivariate logistic regression to adjust for potential confounding variables, no statistically significant difference was observed in mortality between the two groups (OR 1.12, 95% CI 0.55-2.28, P=0.745). Univariate linear regression analysis revealed a mean length of stay (4.22 days, 95% 0.38- 0.99, P<0.001) for patients with Parkinson's disease, compared to (3.54 days, 95% CI 3.54-3.58, P<0.001) for patients without Parkinson's disease. However, multivariate linear regression analysis showed only a slightly smaller increase in length of stay for patients with Parkinson's disease (3.84 days, 95% CI 3.29-3.41, P=0.003) compared to those without (3.35 days, 95% CI 3.29-3.41, P=0.003). A graphical representation of the length of stay with adjusted predicted margins is shown in Figure 1 for patients with and without Parkinson's disease.

No statistically significant difference was noted in the total cost of hospitalization between the two groups (USD 43265, 95% CI 41913-44617) vs (USD 43650, 95% CI 40322- 46977, P=0.815) (Table 2).

Additionally, several secondary outcomes were analyzed. After adjusting for potential confounding variables, it was found that Parkinson's disease was associated with an increased risk of constipation (OR 1.54, 95% CI 1.22-1.94, P<0.001), malnutrition (OR 1.25, 95% CI 0.98-1.61, P=0.007), frailty (OR 2.88, 95% CI 2.47-3.36, P<0.001), pneumonia (OR 1.14, 95% CI 1.11-1.69, P=0.002), and palliative care involvement (OR 1.88, 95% CI 1.36-2.59, P<0.001). However, the incidence of major bleeding episodes was lower in patients with Parkinson's disease compared to those without (OR 0.80, 95% CI 0.66-0.96, P=0.019). No significant differences were observed in the risks of minor bleeding episodes (OR 5.31, 95% CI 0.67-42.10, P-0.114), blood transfusions (OR 1, 95% CI 0.85-1.16, P=0.984), acute respiratory failure (OR 1.17, 95% CI 0.78-1.74, P=0.437), sepsis (OR 1.01, 95% CI 0.45-2.29, P=0.966), acute kidney injury (OR 0.86, 95% CI 0.71-1.06, P=0.171), acute coronary syndromes (OR 0.38, 95% CI 0.09-1.55, P=0.181), and invasive mechanical ventilation (OR 1.16 95% CI 0.73-1.87, P=0.515) (Table 3).

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Table 1 Comparison of baseline characteristics of Anemia patients with and without Parkinson's disease

	Anemia without Parkinson's	Anemia with Parkinson's	P-Value
No. of patients	312691	3704	
Patient Characteristics			
Gender (%)			P<0.001
Male	117290 (37.51)	1829 (49.39)	
Female	195401 (62.49)	1875 (50.61)	
Age			P<0.001
Mean Age (SD)	64.62(19.32)	78.42(8.72)	
Age Distribution (%)			P<0.001
18-35	19293 (6.17)	0 (0)	
36-45	26422 (8.45)	0 (0)	
46-64	79236 (25.34)	235 (6.34)	
>65	187740 (60.04)	3469 (93.66)	
Race (%)			P<0.001
White	200873 (64.24)	2949 (79.63)	
Black	67791 (21.68)	374 (10.11)	
Hispanic	34459 (11.02)	280 (7.55)	
Other	9537 (3.05)	100 (2.71)	
Median household income national quartile for patient zip code (%)			P<0.001
$1-$49,999	106065 (33.92)	977 (26.39)	
$50,000-$64,999	81988 (26.22)	912 (24.63)	
$65,000-$85,999	70825 (22.65)	947 (25.58)	
>$86,000	53814 (17.21)	867 (23.4)	
Charlson comorbidity index (%)			P<0.001
0	72732 (23.26)	365 (9.85)	
1	55690 (17.81)	805 (21.73)	
2	48905 (15.64)	690 (18.62)	
3 or more	135364 (43.29)	1845 (49.8)	
Insurance Provider (%)			P<0.001
Medicare	193806 (61.98)	3404 (91.9)	
Medicaid	44215 (14.14)	91 (2.47)	
Private	58161 (18.6)	193 (5.22)	
Uninsured	16541 (5.29)	15 (0.41)	
Comorbidities (%)			
Hypertension	98185 (31.4)	1315 (35.49)	P = 0.0163
Diabetes Mellitus	75421 (24.12)	1015 (27.4)	P = 0.0355
Chronic Kidney Disease			
CKD2	3158 (1.01)	60 (1.62)	P = 0.1016
CKD3	33020 (10.56)	610 (16.46)	P<0.001
CKD4	12351 (3.95)	115 (3.1)	P = 0.2596
CKD5	1814 (0.58)	10 (0.27)	P = 0.2656
CKD Unspecified	15697 (5.02)	260 (7.02)	P = 0.0118
ESRD	16010 (5.12)	90 (2.43)	P<0.001
Hyperlipidemia (HLD)	111975 (35.81)	1845 (49.8)	P<0.001
Fluid and Electrolyte Disorders	77360 (24.74)	1035 (27.94)	P = 0.0431
Discharge Disposition (%)			P<0.001
Home	242023 (77.4)	2131 (57.52)	
Home with home health	54471 (17.42)	1406 (37.95)	
Skilled nursing facility	7098 (2.27)	150 (4.06)	
Against Medical Advice	9131 (2.92)	15 (0.4)	
Hospital characteristics (%)			
Bed size of hospital (STRATA)			P = 0.1272
Small	80831 (25.85)	1015 (27.4)	
Medium	96278 (30.79)	1225 (33.06)	
Large	135583 (43.36)	1465 (39.54)	
Hospital location			P = 0.6703
Rural	33927 (10.85)	420 (11.34)	
Urban	278764 (89.15)	3284 (88.66)	
Hospital Teaching Status			P = 0.6461
Non-teaching hospital	95840 (30.65)	1165 (31.44)	
Teaching hospital	216851 (69.35)	2539 (68.56)	
Region of hospital			P = 0.1598
Northeast	60130 (19.23)	820 (22.13)	
Midwest	63852 (20.42)	785 (21.19)	
South	141055 (45.11)	1540 (41.57)	
West	47623 (15.23)	560 (15.11)	

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Table 2 Comparison of primary and secondary outcomes of Anemia patients with and without Parkinson's

	Anemia without Parkinson's	Anemia with Parkinson's	P-value
LOS Days (Unadjusted)	3.54(3.50-3.58)	4.22(0.38-0.99)	P<0.001
LOS Days (Adjusted)	3.35(3.29-3.41)	3.84(3.29- 3.41)	P=0.03
Total Charges USD (Unadjusted)	42909(41975-438420	43306(-2906-3700)	P= 0.814
Total Charges USD (Adjusted)	43265(41913-44617)	43650(40322- 46977)	P= 0.815
	Odds of Mortality in Anemia patients with and without Parkinson's disease		
	Odds Ratio	95 % CI	P value
Mortality			
Unadjusted Odds Ratio (Univariate logistic regression)	1.29	(0.64-2.61)	P= 0.469
Adjusted Odds Ratio (Multivariate logistic regression)	1.12	(0.55- 2.28)	P=0.745

USD, United States Dollar; LOS, length of stay; CI, confidence interval

Table 3 Comparison of proportions and adjusted Odds Ratios of secondary outcomes in Anemia patients with and without Parkinson's

Secondary Outcomes	Anemia without Parkinson's (%)	Anemia with Parkinson's (%)	Unadjusted OR (95% CI)	P value	Adjusted OR (95% CI)	P-value
Sepsis	0.85	0.94	1.10(0.52-2.34)	P=0.798	1.01(0.45- 2.29)	P= 0.966
Invasive Mechanical Ventilation	1.92	2.69	1.41(0.900-2.21)	P=0.133	1.16(0.73-1.87)	P=0.515
Acute coronary syndrome	0.56	0.4	0.71(0.22-2.21)	P=0.555	0.38(0.09- 1.55)	P= 0.181
Acute kidney injury	18.07	21.05	1.20(1.01-1.44)	P=0.038	0.86(0.71-1.06)	P=0.171
Intensive care unit	2.31	2.83	1.2390.79-1.91)	P=0.350	1.06(0.67-1.68)	P = 0.791
Acute respiratory failure	2.58	3.5	1.37(0.92-2.02)	P= 0.116	1.17(0.78-1.74)	P= 0.437
Weight loss	1.52	1.21	.079(0.411-1.53)	P=0.496	0.81(0.42- 1.59)	P=0.558
Diarrhea	1.44	1.48	1.02(0.56-1.86)	P=.929	1.00(0.53- 1.88)	P=0.996
Constipation	7.6	12.415	1.72(1.38-2.14)	P<0.001	1.54(1.22-1.94)	P<0.001
Malnutrition	7.6	10.39	1.40(1.11-1.78)	P=0.004	1.25(0.98-1.61)	P=0.007
Frailty	18.14	44.26	3.58(3.09-4.14)	P<0.001	2.88(2.47-3.36)	P<0.001
Palliative care	2.52	5.8	2.37(1.74-3.23)	P<0.001	1.88(1.36-2.59)	P<0.001
Major Bleed	21.09	21.45	1.02(0.85-1.21)	P= 0.808	0.80(0.66-0.96)	P=0.019
Minor Bleed	0.03	0.13	4.22(0.56-31.53)	P=0.160	5.31(0.67-42.10)	P=0.114
Blood transfusion	49.99	50.33	1.01(0.87-1.17)	P=0.858	1.00(0.85-1.16)	P=0.984
Pneumonia	2.345	3.45	1.35(0.92-1.97)	P=0.116	1.14(1.11-1.69)	P=0.002

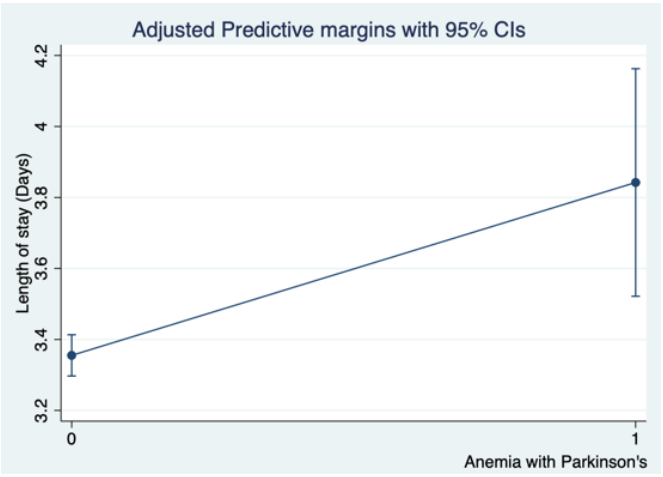

Figure 1 Adjusted predictive margins of anemia patients with and without Parkinson's disease.

Discussion

The findings of our study revealed that PD did not emerge as an independent predictor of mortality in this cohort. However, the nuanced analysis exposed subtle yet significant associations. Patients with PD experienced a modest increase in the length of hospital stay, a finding that warrants attention in the context of disease management and healthcare resource planning. Although the average length of stay did not significantly increase, patients with Parkinson's disease tended to stay in the hospital for longer periods on the same day. This can be attributed to several apparent reasons, such as the higher risk of constipation and malnutrition associated with Parkinson's disease, which contribute to a heavier disease burden in this patient population, resulting in longer hospital stays compared to those without the condition. Plenty of literature attests to the prolonged hospitalization of PD patients in cases where recovery and discharge hinge on mobility conditions such as joint replacements or fractures. For instance, a recent meta-analysis encompassing 124,163 patients, found that length of stay was significantly increased in PD patients undergoing total joint arthroplasties.[9] Nevertheless, there exists a noteworthy literature gap exploring length of stay for conditions less explicitly related to movement.

The prevalence of constipation in individuals with Parkinson's disease is well-documented in the scientific literature, with a prevalence ranging from one-quarter (25%) to almost two thirds (63%) of patients with Parkinson's disease experiencing chronic constipation, depending on diagnostic criteria.[10] Prior research suggests that Parkinson's disease increases the risk of constipation, and thereby the length of hospital stays, in a multitude of ways. Patients with Parkinson's disease are deficient in dopamine, a key neurotransmitter involved in regulating bowel movements. Lack of dopamine impairs muscle movement control, leading to gastrointestinal issues such as constipation. Parkinson's disease is also associated with autonomic nervous system dysfunction, leading to slower movement of food throughout the digestive tract which can also lead to constipation.[11]

Other factors include muscle rigidity, which interferes in the contraction and relaxation of muscles involved in bowel movements, decreased physical activity due to tremors and bradykinesia, and dietary changes as a result of hospitalization, resulting in reduced fiber intake and/or reduced water intake. Furthermore, PD patients

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are commonly prescribed anticholinergics, of which side effects include constipation. A recent study found that patients with signs and symptoms of constipation experienced a lengthier median length of stay in the hospital, when compared to patients without constipation (10 days vs. 9 days where $p=0.004$).[12]

The association between malnutrition and Parkinson's disease has also been investigated in available scientific literature, with a number of factors playing into malnutrition. Over 80% of patients with PD develop dysphagia throughout the course of their disease. This impairment in swallowing not only reduces the quality of life, but also can reduce the intake of medication and lead to malnutrition. Both inadequate medication intake and malnutrition lead to extended hospital stays and often require both additional time, and resources to address.[13] Moreover, anosmia and dysgeusia are well reported symptoms in PD with anosmia affecting up to 90% of patients and dysgeusia affecting up to 27% of patients.[14] The compromised olfactory and gustatory senses can be a significant impediment to the intake of sufficient nutrients. An additional significant contributor to malnutrition may be attributed to the recognized nausea and vomiting side effects associated with PD medications such as Levodopa, dopamine agonists, and anticholinergics. It is also important to note that chronic malnutrition can lead to nutritional deficiencies. Nutritional deficiencies, such as inadequate or poor absorption of essential nutrients such as iron, vitamin B12 and folate can impair the body's red blood cell production and lead to other concurrent health challenges such as anemia.[15]

Additionally, logistical factors may play a role, as our analysis revealed that patients with Parkinson's disease were more likely to be discharged to nursing homes, which may require additional time for transportation and logistical arrangements, leading to delayed discharge on the same day. According to an analysis of Medicare data, approximately 25% of people with Parkinson's disease reside in a long-term care facility such as a nursing home or assisted living property.[16] However, without further information, it is difficult to determine the specific cause, and this issue can be explored and analyzed retrospectively. The economic aspect, as gauged by total hospitalization costs, demonstrated no substantial difference between the PD and non-PD groups, indicating a potential area for further investigation. Kruse et al. conducted a prospective study involving 228 patients with Parkinson's disease, with the aim of analyzing the cost driving predictors of healthcare resource utilization. These predictors included total and direct costs. The study found that Parkinson's disease was associated with increased resource utilization, and that patients in the later stages of the disease were more likely to incur higher costs compared to those in the early stages of the disease.[17]

Of particular interest were the multifaceted comorbidities associated with PD in anemic patients.The heightened probability of constipation, malnutrition, frailty, pneumonia, and the necessity for palliative care serves to emphasize the intricate interrelationship between Parkinson's Disease and the general health status of those affected by anemia. Clinicians should give particular attention to the comorbidity of pneumonia, as aspiration pneumonia is highlighted as the leading cause of death in PD patients.[18] Frailty also stands as a significant area of concern, considering that the risk of falls in PD patients is more than doubled, and associated with detrimental adverse outcomes such as fragility fractures.[19]

Surprisingly, the inverse relationship was observed concerning bleeding episodes. Patients with PD exhibited a reduced likelihood of major bleeding events. A possible explanation for this can be that the increased risk of falls among patients with Parkinson's disease renders the use of blood thinner medications less probable as they age due to the potential hazards outweighing the benefits. Nonetheless, this matter warrants additional prospective analysis, as the National Inpatient Sample (NIS) lacks information on medications and treatments.

Our study offers valuable insights into the complex landscape of PD and anemia co-occurrence. While PD may not independently predict mortality in anemic patients, its influence on clinical outcomes and resource utilization is unmistakable. A recently published meta-analysis of articles over the last two decades (2000-2020) shows that anemia can be associated with a higher risk of Parkinson's disease when compared to people without anemia. In addition, a recent population-based, large-scale cohort study consisting of over 474,000 individuals (aged 40-79) found that anemia was associated with a higher risk of Parkinson's disease in middle-aged men, further warranting additional investigation into the various pathophysiological processes between brain dysfunction, PD and Hb abnormalitie.[20] The observed associations emphasize the need for a comprehensive approach to patient care, integrating Parkinson's disease management strategies with targeted interventions for anemia-related complications.

A review published by the International Journal of Integrated Care provides a high-level summary of different best practices to integrate care for multiple chronic diseases. To apply these suggestions with concurrent health conditions such as PD and anemia in mind, an integrated approach could include regular monitoring of symptoms related to both PD and anemia. Another suggestion is medication management, in particular, managing Parkinson's disease medications to optimize motor control yet reduce side effects that may either contribute to anemia or exacerbate complications related to anemia. This includes considering the impact that certain PD medications may have on nutritional status and deficiencies. Building on to that, integrated care could also consist of incorporating the expertise of other health care specialists such as dieticians, nutritionists and physical therapists to develop a nutrition or physical activity regimen that is recommended for patients with PD yet mitigates risk for anemia. Consulting physical therapists might also be beneficial in not only reducing the risk of falls in patients with PD but also reducing anemia-related fatigue that might be present in patients with both conditions. Lastly, the importance of educational programs, collaborative care and frequent follow-ups are paramount in promoting not only continuity of care but also comprehensive, collaborative care.[21]

Given the inherent limitations of retrospective analyses using administrative databases, it is crucial to approach the findings of our study with caution. Reliance solely on ICD-10-CM codes for diagnoses such as Immune Thrombocytopenic Purpura (ITP) and Heart Failure may lead to potential inaccuracies due to the absence of corresponding laboratory test data in the National Inpatient Sample (NIS) database. Furthermore, essential clinical information, such as patient symptoms, prescribed medications, and functional capacity, was inaccessible from this dataset. The absence of detailed clinical data makes it challenging to rule out any inaccuracies or undercoding-related biases introduced by healthcare providers while coding patient records. These biases could have influenced diagnosis accuracy during the analysis process. Additionally, the structure of the NIS poses challenges. It maintains an extensive database of hospitalization records per admission rather than per person, meaning that a single individual can be counted multiple times if admitted to different hospitals or experienced more than one hospital stay during the study period. As a result, analyzing secondary diagnoses in relation to each specific admission is hindered by the timing and sequencing information being inaccessible due to this methodology issue.

It is important to acknowledge that selection bias is also a potential concern with any retrospective analysis. Despite conducting thorough multivariate regression analysis aimed at mitigating this risk and ensuring result accuracy, there remains room for further exploration through prospective trials for validation purposes.

Conclusion

In conclusion, our comprehensive analysis of hospitalization data for individuals with both Parkinson's disease (PD) and anemia provides valuable insights into the relationship between these conditions. While PD alone does not predict mortality, its correlation with a decrease in major bleeding episodes is noteworthy. The study highlights the heightened vulnerability of PD patients to various adverse outcomes, including longer hospital stays and a higher risk of malnutrition, frailty, constipation, pneumonia, and palliative care involvement. These findings underscore the necessity for tailored management strategies for PD to mitigate the impact of these complications on patients' quality of life. The observed associations warrant further prospective investigations to validate and expand upon our retrospective analysis, leading to a deeper understanding of the intricate relationship between PD and anemia and informing more efficacious clinical interventions.

Acknowledgments

None.

Conflicts of interest

Authors declare that there is no conflict of interest.

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