

Metoclopramide and Levosulpiride Use and Subsequent Levodopa Prescription in the Korean Elderly: The Prescribing Cascade

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Abstract: The aim of this study was to investigate the prescribing cascade phenomenon of dopaminergic drugs such as levodopa in the management of gastroprokinetic drugs induced parkinsonism. Based on the Korea National Health Insurance Service (NHIS)-Senior Cohort Database, we analyzed patients aged 65 years, between 2009 and 2013, who obtained new prescriptions for levodopa through the NHIS during this period. Those who were prescribed levodopa from 2002 to 2008 were excluded, only patients who were prescribed metoclopramide and levosulpiride within 90 days of receiving the levodopa prescription were included. Those who did not receive levodopa were used as a control group for 1:3 age and sex matching. We assessed 1824 and 1197 levodopa cases for metoclopramide and levosulpiride use, respectively. The matched controls for each levodopa case were 5472 and 3591, respectively. We used conditional logistic regression to determine the odds ratio (OR) for initiation of levodopa therapy in patients using metoclopramide and levosulpiride, relative to nonusers, after adjusting for age, sex, and exposure to antipsychotic medication. Both metoclopramide (OR = 3.04; 95% confidence interval, CI, 2.46–3.77) and levosulpiride (OR = 3.32; 95% CI, 2.56–4.3) users were three times more likely to begin using medication containing levodopa, compared to nonusers. Metoclopramide and levosulpiride were frequently prescribed within 90 days of receiving a prescription for levodopa. Before prescribing levodopa, it should be considered whether the adverse event is actually a side effect caused by metoclopramide and levosulpiride.

Keywords: elderly; Parkinson's disease; prescribing cascade; metoclopramide; levosulpiride; Levodopa medications; drug-induced

1. Introduction

Adverse events associated with medication are quite common. And these place a significant burden on the healthcare system in terms of both health outcomes and costs. A prescribing cascade occurs when a new medication is prescribed to “treat” an adverse drug reaction associated with another medication, based on the misdiagnosis that a new medical condition requiring treatment is present [1]. Prescribing cascades resulting from both recognized and unrecognized adverse reactions may be hazardous to patients. Some studies reported that older adults may be at a higher risk of prescribing

cascades than younger adults [2,3]. This may be because they are more likely to suffer from an adverse drug reaction than the younger population, resulting in a higher possibility of misinterpretation of the reaction as the onset of a new medical condition [1].

The Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-V), [4] defines drug-induced parkinsonism (DIP) as the presence of resting tremor, muscular rigidity, akinesia, or bradykinesia, developing within a few weeks of starting or raising the dosage of a medication (typically a neuroleptic) or after reducing the dosage of an antiparkinsonian agent. Drug-induced movement disorders include DIP, tardive dyskinesia (TD), tardive dystonia, akathisia, myoclonus, and tremors. Amongst these, DIP is the most common movement disorder induced by medications that block dopamine receptors. DIP is the second-most common cause of parkinsonism, and a major cause of the misleading diagnosis of Parkinson's disease (PD). It was initially considered to be present in approximately 4–40% of patients treated with the first neuroleptics [5], however, it has been reported as a complication of treatment.

The risk factors of DIP may be related to several variables including age [6,7], female gender [6], length of exposure [8], dose, and treatment with multiple drugs. Age is the most obvious risk factor for DIP [9–11], because dopamine concentrations decrease and nigral cells degenerate with age [12].

Medications that cause drug-induced parkinsonism include typical and atypical antipsychotics, dopamine depleters, antiemetics, and calcium channel blockers [13–15]. Gastroprokinetic drugs are potent inducers of DIP, especially according to reports in Korea [16]. Metoclopramide and levosulpiride are well-known antiemetic and gastroprokinetic agents commonly used for the treatment of nausea, vomiting, gastroparesis, gastroesophageal reflux disease, and migraine [17–20], and are gastrointestinal prokinetic medications mediated through a blockade of their enteric inhibitory D2 receptors [21]. Besides binding to receptors in the peripheral end organs, thus inducing antiemetic effects via D2 receptor blockade in the area postrema, they also antagonize central D2 receptors, leading to adverse effects including hyperprolactinemia and extrapyramidal side effects. All prokinetics with D2-receptor-antagonizing properties have been found to induce extrapyramidal side effects, although the extent of symptoms varies [13].

Since older age is a risk factor for DIP, the present study aimed to determine the association between the initiation of levodopa therapy and the use of metoclopramide or levosulpiride in the older population. For this purpose, we analyzed the National Health Insurance Service (NHIS)-Senior Cohort Database.

2. Materials and Methods

2.1. Setting and Participants

The NHIS-Senior Cohort Database consists of a randomly selected 10% of the Korean population aged 60 years (550,000 persons), since the end of 2002. The database contains information including demographics, income (including socioeconomic factors), medical records, health screening records, and responses to a questionnaire. In Korea, the National Health Insurance organization recommends health screening in all adults, every two years.

2.2. Patient Selection and Criteria

This study was conducted using two antiemetics: metoclopramide and levosulpiride. For cohorts, we identified patients aged 65 years, between 2009 and 2013, who obtained new prescriptions for levodopa through the NHIS during this period. We extracted the control group and the case group by the method shown in Figure 1.

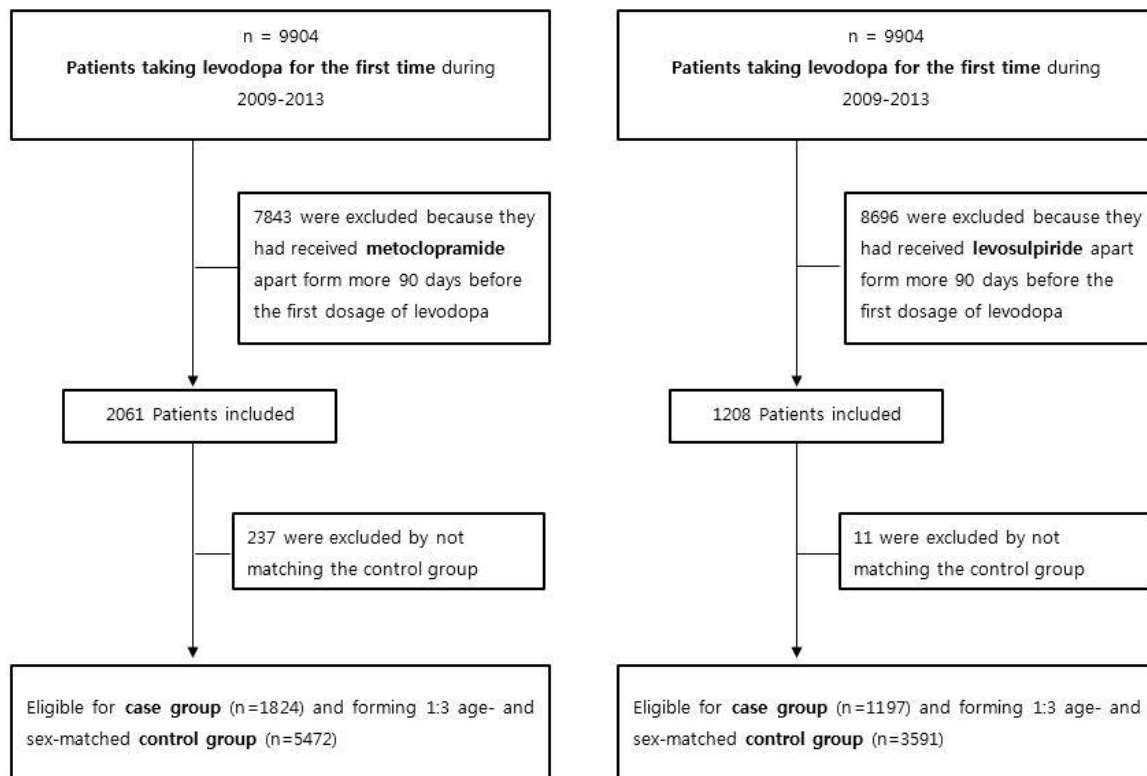


Figure 1. Flowchart of Study Subjects.

2.3. Medication Exposure

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Based on the Korea National Health Insurance Service (NHIS)-Senior Cohort Database, we analyzed based on the aged Korea 65 National years, between the insurance 2009 and Service 2013, who (NHIS) obtained Senior new Cohort prescriptions Database, we for

levodopa analyzed through patients the aged NHIS ≥ 65 during years, the between same time 2009 period and 2013. Those who who obtained were prescribed new prescriptions levodopa from for 2002 levodopa 2008 through were excluded, the NHIS during only patients the same who time were period prescribed. Those who metoclopramide were prescribed and levodopa levosulpiride from within 2002 to 90 2008 days were of receiving; excluded, the only levodopa patients prescription who were prescribed included, metoclopramide and those who and did levosulpiride not receive levodopa within 90 days were of use of receiving as a control the levodopa group for prescription 1:3 age- and were sex included, matching and. We then assessed who did 1824 not and receive 1197 levodopa were cases used for metoclopramide as control group and for levosulpiride 1:3 age- and use sex, respectively; matching. We then assessed matched 1824 controls and 1197 for each levodopa levodopa cases case for metoclopramide were 5472 and 3591, and levosulpiride respectively. use, in addition, respectively, the prescription the matched rate controls of levodopa for each according levodopa to case the were duration 5472 of and metoclopramide 3591, respectively and levosulpiride. In addition, use the was prescription comparison between of levodopa. according to the duration of metoclopramide and levosulpiride use was compared between groups.

2.4. Statistical Analysis

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Odds ratios (ORs) were calculated to assess the association between antiemetic use and initiation of levodopa. Odds ratios (ORs) statistical were analyses calculated were to assess performed the association using SAS version 9.3 software use for conditional initiation logistic of levodopa regression. All statistical which considered analyses were the performed initiation of using levodopa SAS version therapy 9 as 3 software the outcome for conditional of interest. Additionally, logistic regression, obtaining which a prescription considered for the metoclopramide initiation of levodopa or levosulpiride therapy in the the outcome last 90 days of interest prior to. the Additionally, index date obtaining was considered a prescription the exposure for metoclopramide of interest. Then, or we levosulpiride developed in a regression model days prior that adjusted to the index for age, date sex, was nursing considered home the resident exposure status, of interest history. of Then, hospital we developed care in the last regression 120 days model prior to that the adjusted index date, for age, and sex, any nursing use of antipsychotic, home resident medication status, history (such as hospital chlorpromazine, care the perphenazine, last 120 days haloperidol, pritomide, index date, sulpiride, and any risperidone, use of antipsychotic olanzapine, ziprasidone, medication and (such as aripiprazole) as chlorpromazine, during the 90 perphenazine, day period prior to haloperidol, to the index pritomide, date. After sulpiride, initial analyses, risperidone, interaction olanzapine, terms were ziprasidone, added to and the model aripiprazole) to determine during whether 90-day the period of prior to metoclopramide the index date of levosulpiride. After initial analyses, was modified interaction by age terms sex, or were exposure added to antipsychotic the model to medication determine whether. All P-values the effect were of two metoclopramide-tailed; P-value or of levosulpiride < 0.05 indicated was statistical modified significance by age, sex, or exposure to antipsychotic medication. All P-values were two-tailed; a P-value of < 0.05 indicated statistical significance.

3. Results

3. Results

3.1. Metoclopramide Use and Subsequent Levodopa Prescription

Table 1 displays the characteristics of the study population for metoclopramide, which included 1824 cases and 5472 controls. The study population was analyzed by sex, age, use or non-use of metoclopramide, and duration of metoclopramide use. Those who were prescribed metoclopramide were about three times more likely to be prescribed levodopa than those who were not (OR = 3.04; 95% confidence interval, CI, 2.46–3.77) (Table 2). This increased risk persisted even after adjusting for age, sex, and use of antipsychotics (OR = 2.94; 95% CI, 2.35–3.67). As the duration of metoclopramide use increased, the likelihood of taking levodopa increased as well; OR was 2.93 (95% CI, 2.34–3.68) for the 1–19 days group, and 4.18 (95% CI, 2.21–7.89) for the >20 day group.

Table 1. Characteristics of study subjects in terms of preceding metoclopramide prescriptions.

| | | Cases N = 1824 | Controls N = 5472 |
|---|-----------|-------------------|----------------------|
| Sex | Male | 960 (52.63) | 2880 (52.63) |
| | Female | 86 (4.73) | 2592 (47.37) |
| Age (Years) | 65–74 | 694 (38.05) | 2082 (38.05) |
| | 75–84 | 918 (50.33) | 2754 (50.33) |
| | 85 | 212 (11.62) | 636 (11.62) |
| Exposure to Metoclopramide | No | 1645 (90.19) | 5280 (96.49) |
| | Yes | 179 (9.81) | 192 (3.51) |
| Duration of Metoclopramide prescription | None | 1645 (90.19) | 5280 (96.49) |
| | 1–19 days | 157 (8.61) | 175 (3.2) |
| | 20 days | 22 (1.21) | 17 (0.31) |

Data are expressed as N (%).

Table 2. The odds ratios (ORs) for the initiation of levodopa, classified based on the duration of exposure to metoclopramide.

| | | Crude OR (95% CI) | Adjusted OR (95% CI) * |
|----------------------------|-----------|-------------------|------------------------|
| Exposure to metoclopramide | No | 1 ** | 1 ** |
| | Yes | 3.04 (2.46,3.77) | 2.94 (2.35,3.67) |
| Duration | None | 1 ** | 1 ** |
| | 1–19 days | 2.93 (2.34,3.68) | 2.82 (2.23,3.56) |
| | 20 days | 4.18 (2.21,7.89) | 4.14 (2.15,7.98) |

Abbreviations: CI, confidence interval; OR, odds ratio. * Adjusted for age, sex, and exposure to antipsychotic medications. ** Referent category.

3.2. Levosulpiride Use and Subsequent Levodopa Prescription

The study population for levosulpiride consisted of 1197 cases and 3591 controls and they were also analyzed in terms of sex, age, use or non-use of levosulpiride, and the duration of use (Table 3). Table 4 exhibits the risk of using levodopa, according to pre-existing use or non-use of levosulpiride. Those individuals who were prescribed levosulpiride were around three times more likely to be prescribed levodopa (OR = 3.32; 95% CI, 2.56–4.30). After adjusting for age, sex, and use of antipsychotics, the risk increased slightly (OR = 3.30; 95% CI, 2.52–4.32). As the duration of levosulpiride use was longer, the likelihood of taking levodopa was found to be greater; ORs were 2.29 (95% CI, 2.69–3.11) for the 1–19 days group, and 9.79 (95% CI, 5.65–16.97) for the >20 day group.

Table 3. Characteristics of study subjects in terms of preceding levosulpiride prescriptions.

| | | Cases N = 1197 | Controls N = 3591 |
|--|-----------|-------------------|----------------------|
| Sex | Male | 609(50.88) | 1827 (50.88) |
| | Female | 588(49.12) | 1764 (49.12) |
| Age (Years) | 65–74 | 472 (39.43) | 1416 (39.43) |
| | 75–84 | 584 (48.79) | 1752 (48.79) |
| | 85 | 141 (11.78) | 423 (11.78) |
| Exposure to levosulpiride | No | 1070 (89.39) | 3465 (96.49) |
| | Yes | 127 (10.61) | 126 (3.51) |
| Duration of levosulpiride prescription | None | 1070 (89.39) | 3465 (96.49) |
| | 1–19 days | 75 (6.27) | 109 (3.04) |
| | 20 days | 52 (4.34) | 17 (0.47) |

Data are expressed as N (%).

Table 4. The odds ratios (ORs) for the initiation of levodopa, classified based on the duration of exposure to levosulpiride.

| | | Crude OR (95% CI) | Adjusted OR (95% CI) * |
|---------------------------|-----------|-------------------|------------------------|
| Exposure to Levosulpiride | No | 1 ** | 1 ** |
| | Yes | 3.32 (2.56,4.3) | 3.3 (2.52,4.32) |
| Duration | Non | 1 ** | 1 ** |
| | 1–19 days | 2.29 (1.69,3.11) | 2.24 (1.64,3.08) |
| | 20 days | 9.79 (5.65,16.97) | 10.24 (5.82,17.99) |

Abbreviations: CI, confidence interval; OR, odds ratio. * Adjusted for age, sex, and exposure to antipsychotic medications. ** Referent category.

4. Discussion

DIP is important because it is a common etiology of parkinsonism and is frequently either unrecognized or misdiagnosed as PD. In addition, parkinsonism in patients with DIP can be severe enough to affect daily activities and may persist for long periods of time even after terminating the consumption of the medication. Several long-term follow-up studies have revealed that 20–25% of patients with DIP develop persistent and progressive parkinsonian deficits in spite of drug discontinuation [22,23].

Many studies have already demonstrated that antiemetics are associated with DIP [16,24]. In one study in the United States, metoclopramide users were three times more likely to start using levodopa-containing drugs than nonusers (OR = 3.09; 95% CI, 2.25–4.26). In addition, increased risk with increasing daily metoclopramide dose: OR = 1.19 (95% CI, 0.50–2.81) above 0–10 mg per day, 3.33 (95% CI, 1.98–5.58) above 10–20 mg per day, and 5.25 (95% CI, 1.16–8.50) for more than 20 mg a day [16]. In our study, it was found that levodopa prescription increased when antiemetics were used during the preceding period. In clinical practice, levodopa is often prescribed to treat Parkinsonism associated with antiemetics in older adults. This may lead to polypharmacy in such patients, which causes adverse drug reactions and has a significant impact on health and cost.

According to the results of a study on the status of drug use in the older population in 2014, 60.3% of Korean people aged 65 years take more than three types of medication. Given that older adults take multiple medications, it is difficult to determine if the new symptoms are a result of either adverse drug reactions, or aging, therefore, it is necessary to evaluate whether any new symptoms are caused by adverse drug reactions. As other studies have shown that DIP is dose-dependent, the subsequent prescription of levodopa in this study has also increased with longer use of gastroprokinetics [24,25]. In one such study in South Korea, ORs tended to be higher in those exposed to higher chronic cumulative doses and had significant association with increased risk of parkinsonism, depending on

cumulative dose [24]. In our study, the longer the exposure period, the greater the use of levosulpiride than metoclopramide.

In the case of metoclopramide, levodopa was subsequently used 2.82 times for the 1–19 days and 4.14 times for more than 20 days. For levosulpiride, 2.24 times and 10.24 times levodopa prescription were followed-up, respectively. Therefore, when prescribing drugs in the elderly, they should refrain from long-term medication if not needed.

This study has the following limitations. First, not all cases in this paper can be called DIP. Because this study did not consider the NHIS Parkinson's disease diagnostic code and analyzed people who were prescribed levodopa medication, there is a limitation that those prescribed levodopa may not necessarily be diagnosed with DIP. Second, antiparkinsonian medications other than levodopa were not considered. Because DIP treatment does not necessarily use levodopa, there are limitations that other antiparkinsonian disease treatments may also be used. Third, this study is based on the NHIS-Senior Cohort Database, which consisted of elderly adults with national health checkup results, and therefore, there may be selection bias because the database is more likely to include people concerned about their health and wellbeing and adopting a healthier lifestyle than those who do not receive regular medical checkups. Fourth, in this study, the dose dependent DIP was unknown because the daily dose was not known.

Those individuals who undergo health screening at least once every two years may have a greater interest in their health and well-being compared to those who do not and may be more likely to have a healthy lifestyle, which could have created a selection bias.

Notwithstanding these limitations, in this large-scale study, it was found that persons taking a prokinetic medication (metoclopramide or levosulpiride) were at increased risk of being subsequently prescribed levodopa, and this risk tends to increase with longer duration of prokinetic agent use.

5. Conclusions

Metoclopramide and levosulpiride were frequently prescribed within 90 days of a prescription for levodopa. Before prescribing levodopa, we recommend considering whether the adverse health effect is a side effect caused by metoclopramide and levosulpiride.

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References

1. Rochon, P.A.; Gurwitz, J.H. Optimising drug treatment for elderly people: The prescribing cascade. *BMJ Br. Med. J.* **1997**, *315*, 1096. [\[CrossRef\]](#)
2. Vouri, S.M.; van Tuyl, J.S.; Olsen, M.A.; Xian, H.; Schootman, M. An evaluation of a potential calcium channel blocker-lower-extremity edema-loop diuretic prescribing cascade. *J. Am. Pharm. Assoc.* **2018**, *58*, 534–539. [\[CrossRef\]](#)
3. Petrone, K.; Katz, P. Approaches to appropriate drug prescribing for the older adult. *Prim. Care* **2005**, *32*, 755–775. [\[CrossRef\]](#)
4. Association, A.P. *Diagnostic and Statistical Manual of Mental Disorders (DSM-5f)*; American Psychiatric Pub: Washington, DC, USA, 2013.

5. Goldman, D. Treatment of psychotic states with chlorpromazine. *J. Am. Med. Assoc.* **1955**, 157, 1274–1278. [[CrossRef](#)]
6. Ayd, F.J. A survey of drug-induced extrapyramidal reactions. *JAMA* **1961**, 175, 1054–1060. [[CrossRef](#)]
7. Jabs, B.E.; Bartsch, A.J.; Pfuhlmann, B. Susceptibility to neuroleptic-induced parkinsonism—Age and increased substantia nigra echogenicity as putative risk factors. *Eur. Psychiatry* **2003**, 18, 177–181. [[CrossRef](#)]
8. Richardson, M.A.; Haugland, G.; Craig, T.J. Neuroleptic use, parkinsonian symptoms, tardive dyskinesia, and associated factors in child and adolescent psychiatric patients. *Am. J. Psychiatry* **1991**, 148, 1322.
9. Avorn, J.; Bohn, R.L.; Mogun, H.; Gurwitz, J.H.; Monane, M.; Everitt, D.; Walker, A. Neuroleptic drug exposure and treatment of parkinsonism in the elderly: A case-control study. *Am. J. Med.* **1995**, 99, 48–54. [[CrossRef](#)]
10. Susatia, F.; Fernandez, H.H. Drug-induced parkinsonism. *Curr. Treat. Options Neurol.* **2009**, 11, 162–169. [[CrossRef](#)]
11. Thanvi, B.; Treadwell, S. Drug induced parkinsonism: A common cause of parkinsonism in older people. *Postgrad. Med J.* **2009**, 85, 322–326. [[CrossRef](#)]
12. Volkow, N.D.; Yu-Shin, D.; Fowler, J.S.; Gene-Jack, W. Dopamine transporters decrease with age. *J. Nucl. Med.* **1996**, 37, 554.
13. Shin, H.W.; Chung, S.J. Drug-induced parkinsonism. *J. Clin. Neurol.* **2012**, 8, 15–21. [[CrossRef](#)]
14. Ma, H.I.; Kim, J.H.; Chu, M.K.; Oh, M.S.; Yu, K.H.; Kim, J.; Hahm, W.; Kim, Y.J.; Lee, B.C. Diabetes mellitus and drug-induced Parkinsonism: A case-control study. *J. Neurol. Sci.* **2009**, 284, 140–143. [[CrossRef](#)]
15. Lopez-Sendon, J.L.; Mena, M.A.; de Yebenes, J.G. Drug-induced parkinsonism in the elderly: Incidence, management and prevention. *Drugs Aging* **2012**, 29, 105–118. [[CrossRef](#)]
16. Shin, H.W.; Kim, M.J.; Kim, J.S.; Lee, M.C.; Chung, S.J. Levosulpiride-induced movement disorders. *Mov. Disord.* **2009**, 24, 2249–2253. [[CrossRef](#)]
17. Madjunkova, S.; Maltepe, C.; Farine, D.; Koren, G. Patterns of antiemetic use among American women with nausea and vomiting of pregnancy. *Obstet. Gynecol.* **2014**, 123, 155S. [[CrossRef](#)]
18. Wallenborn, J.; Gelbrich, G.; Bulst, D.; Behrends, K.; Wallenborn, H.; Rohrbach, A.; Krause, U.; Kühnast, T.; Wiegel, M.; Oltho, D. Prevention of postoperative nausea and vomiting by metoclopramide combined with dexamethasone: Randomised double blind multicentre trial. *BMJ* **2006**, 333, 324. [[CrossRef](#)]
19. Schriever, J.; Bühlen, M.; Broich, K. Current state of knowledge and developments in the prophylaxis and acute treatment of migraine. *Bundesgesundheitsblatt Gesundheitsforschung Gesundheitsschutz.* **2014**, 57, 974–982. [[CrossRef](#)]
20. Sayana, A.; Barshiliya, Y. Comparative Study of Metoclopramide, Ondansetron, and Granisetron in Prophylaxis of Post operative Nausea and Vomiting in Patient Undergoing Laparoscopic Cholecystectomy Under General Anaesthesia. *Asian J. Pharm. Life Sci.* **2012**, 2231, 4423.
21. Tonini, M.; Cipollina, L.; Poluzzi, E.; Crema, F.; Corazza, G.; De Ponti, F. Clinical implications of enteric and central D2 receptor blockade by antidopaminergic gastrointestinal prokinetics. *Aliment. Pharmacol. Ther.* **2004**, 19, 379–390. [[CrossRef](#)]
22. Llau, M.; Nguyen, L.; Senard, J.; Rascol, O.; Montastruc, J. Drug-induced parkinsonian syndromes: A 10-year experience at a regional center of pharmaco-vigilance. *Rev. Neurol.* **1994**, 150, 757–762.
23. Martí, J.M.; Poza, J. Drug-induced or aggravated parkinsonism: Clinical signs and the changing pattern of implicated drugs. *Neurologia* **1996**, 11, 10–15.
24. Kim, S.; Cheon, S.M.; Suh, H.S. Association Between Drug Exposure and Occurrence of Parkinsonism in Korea: A Population-Based Case-Control Study. *Ann. Pharm.* **2019**. [[CrossRef](#)]
25. Avorn, J.; Gurwitz, J.H.; Bohn, R.L.; Mogun, H.; Monane, M.; Walker, A. Increased incidence of levodopa therapy following metoclopramide use. *JAMA* **1995**, 274, 1780–1782. [[CrossRef](#)]

