# Factors and Costs Related to Duplicate Medication Orders in Outpatient Specialist Clinic of a Public Hospital

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**ABSTRACT**

**Introduction:**

Duplicate medication orders are defined as clinically redundant orders, or prescriptions for identical medications or those belonging to the same pharmacological or therapeutic class within an overlapping period. Such occurrences pose significant risks to patient safety and contribute to the waste of resources. In Malaysia, the implementation of the Pharmacy Information System (PhIS) marks a crucial step in leveraging technology to enhance the efficiency and safety of the local dispensing system. The study aimed to identify duplicate medication orders, assess the associated risks, and quantify the costs resulting from these duplicates.

**Methods:**

A cross-sectional study was conducted in 2021 among patients newly registered and attending the Outpatient Specialist Clinics or Haemodialysis Unit at Hospital Jerantut. Patient demographic data and medication histories were retrospectively obtained from the patient registry and the Pharmacy Information System (PhIS), respectively. Duplicate medication orders were identified as prescriptions for identical medications or those with clinical redundancy within an overlapping period. The costs associated with these duplications were calculated based on the purchasing cost of the medications. The results were analyzed using descriptive statistics and multiple logistic regression.

**Results:**

Out of the 570 patients included in the study, 12.3% (n=70) received duplicate medication orders. Multiple logistic regression analysis identified several factors significantly associated with medication duplication: age (OR=1.02, 95% CI=1.00-1.04), the use of gastrointestinal medications (OR=4.07, 95% CI=1.65-10.07), and the number of prescriptions dispensed (OR=9.35, 95% CI=4.21-20.78), with an $R^2$ value of 0.353. The total annual cost incurred due to duplicate medication orders was RM970.86.

**Conclusion:**

The proportion of duplicate medication orders in this study was relatively low. However, increasing age, the use of gastrointestinal medications, and the number of prescriptions dispensed per patient per year were significantly associated with the occurrence of duplicate medication orders. These findings suggest a positive impact of the Pharmacy Information System (PhIS). Nonetheless, continuous improvements to the system are needed, and the role of pharmacists should be further emphasized to ensure the appropriate medication supply to patients. Future studies are recommended to evaluate the cost-effectiveness of the PhIS in addressing medication duplication.

**Keywords:**

Polypharmacy, patient safety, information systems, duplicate medication orders, medication duplication

## INTRODUCTION

In Malaysia, about one in two elderly individuals experience polypharmacy, a known risk factor for fall injuries.[1] This is worrying, as the fall rate among older Malaysians is slightly higher (about 40%) than in the rest of Asia.[1] Those seeking care from healthcare facilities are more likely to experience polypharmacy than those who self-treat at home, highlighting a gap in the healthcare system.[1] Polypharmacy can be illustrated in various ways, and medication duplication is one of them.[2] Although polypharmacy and medication duplication are often used interchangeably, the latter specifically focuses on unnecessary medication use and is sometimes underemphasized.[3]

Studies have shown that the prevalence of medication duplication is about 11.1% in Catalonia and 8.8% in Japan.[4,5] Cases of inappropriate medication duplication include the concurrent use of two or more medications with similar pharmacodynamics, medications targeting similar molecular structures, or patients unintentionally taking the same medication multiple times, exceeding the recommended dose.[6] Medication duplication can compromise patient safety and lead to unnecessary wastage.[7] From a clinical perspective, there is no added therapeutic benefit from duplication, and patients are at greater risk of overdose, adverse drug reactions (ADRs), and drug-drug interactions (DDIs).[8] On the contrary, the risk of overdose, ADR and DDIs increase in patients with duplicate medication orders.[9]

As national healthcare expenditure continues to soar, medication duplication contributed by unnecessary and wasteful prescribing of medicines, including prescribing without ascertaining whether patients have previously received similar medicines, increased the financial burden on the already financially constrained healthcare system.[10-12]

A potential solution to medication duplication is technological intervention. To address this issue, the Ministry of Health Malaysia (MOH) introduced the Pharmacy Information System (PhIS), transitioning

pharmacy management from manual processes to a more systematic, computerized system. The PhIS enables pharmacists to review patients' medication histories from previous visits, reducing the risk of medication duplication.[13] As of the 2019 Annual MOH report, about 42% of public healthcare facilities in Malaysia had implemented PhIS.[14] This marks a significant step towards leveraging Health Information Technology (HIT) to improve data management within the healthcare system. However, to optimize HIT, user engagement and continuous evaluation are essential. One proposed strategy is to monitor electronic medication orders and collect data to identify errors and improve the system accordingly.[15]

Given that a decade has passed since the introduction of PhIS in 2013, it is timely to assess its effectiveness in addressing issues such as medication duplication and to explore its potential for wider implementation.[16] The aim of this study was to determine the prevalence of duplicate medication orders, identify associated factors, and quantify the costs of medication duplication among outpatients.

## METHODS

### *Study Design and Setting*

This was a cross-sectional study conducted at Hospital Jerantut, a district hospital in Malaysia. The hospital has a total of 11 Outpatient Specialist Clinics and a Hemodialysis Unit (HDU).

### *Study Population*

This study included patients who were newly registered between January 1 and December 31, 2021, at Hospital Jerantut's Outpatient Specialist Clinics and the HDU, regardless of whether they received follow-up care at one or more clinics. To prevent duplication, especially among patients attending multiple clinics, a careful review of each patient's records was conducted. Patients without medication profiles in the Pharmacy Information System (PhIS) were excluded from the analysis. Additionally, patients from the Ophthalmology Clinic were excluded due to resource constraints.

### *Sample Size*

The sample size was calculated based on the 8.8% prevalence of duplicate medication orders[5] and the five independent variables for this study. These variables were: (a) age; (b) types of medications received; (c) number of prescriptions dispensed per year; (d) types of clinics attended; and (e) whether the patient received follow-up care in one or multiple clinics. The sample size was estimated using the multiple logistic regression formula derived from Peduzzi et al., expressed as n = 10k/p, where *k* represents the number of covariates (independent variables) and *p* is the proportion of patients with the outcome of interest.[17] With an anticipated 8.8% event rate[5] (p = 0.088) and assuming five predictors, a sample of 568 patients, rounded up to 570, was estimated to be needed for the study.

However, the final logistic regression model included 19 predictors due to the creation of dummy variables for the categorical variables 'types of medications received' and 'types of clinics attended.' This resulted in an events per variable (EPV) lower than the recommended threshold of 10 EPV.[17] Nevertheless, a recent simulation study by Austin and Steyerberg has shown that EPV values lower than 10 can still provide reasonable general outcome predictions, though not for individual predictors".[18]

### *Sampling Technique*

Proportionate stratified random sampling with replacement was used to draw patients from the ten Outpatient Specialist Clinics and HDU. In this study, one strata unit was equivalent to each clinic or unit. To calculate the number needed for each stratum, the following calculation was used:

$$\frac{\textbf{Sample size (n = 570)}}{\textbf{Population Size (N = 1299)}} \times \textbf{Stratum size for each clinic or unit}$$

According to the number of samples required from each stratum, samples were selected based on simple random sampling using computer-generated random numbers using a web-based online application named "Research Randomizer".[19]

### *Data Collection*

Data collection was conducted from September to October 2022. A list of patient names from the Outpatient Specialist Clinics and HDU was obtained, and samples were identified from each clinic according to the required number per clinic/stratum. In the first round of data cleaning, 81 patients were excluded from all strata due to the absence of medication profiles in the PhIS. To replace these patients, a second round of simple random sampling was conducted. During this round, nine patients were found to have been selected twice under different strata due to multiple clinic follow-ups; these patients were excluded in the second round of data cleaning. Sampling was then repeated to select the final 570 patients with complete data.

Demographic information and follow-up clinic details for each patient were extracted from the patient registry, and their medication profiles were manually reviewed in PhIS. Duplicate medication orders were identified based on prescriptions with overlapping time periods. All relevant data were recorded in the data collection form. For this study, the cost of duplication was calculated only for duplicate medications with later prescription dates, excluding medications that were originally or initially prescribed. The cost of duplicated medications was based on the hospital's drug catalogue, reflecting the purchasing cost. These costs do not account for payments made by patients.

***Statistical Analysis***

All data were entered and analyzed using SPSS software version 21. Multiple logistic regression was employed to explore factors associated with duplicate medication orders, adjusting for potential confounders. Variables with a p-value < 0.25 in the simple logistic regression model were included in the multiple logistic regression model.[20] The stepwise technique was used for variable selection. To ensure the validity of the analysis, multicollinearity and interaction tests were conducted to confirm that the assumptions for multiple logistic regression were met.

**RESULTS**

***Demographic Variables***

Among the 570 samples included in the study, ages ranged from one to 93 years. The baseline characteristics and demographic data are presented in Table 1. A total of 1,473 prescriptions were dispensed to these patients in 2021. The maximum number of prescriptions per patient was 31, while the median number of prescriptions per patient was two. Most patients were managed by a single clinic and received two or fewer prescriptions in 2021.

***Duplicate Medication Orders***

Among the 570 samples, 70 patients (12.3%) received duplicate medication orders. Of the 1,473 prescriptions these patients received, 171 (11.6%) were duplicate orders. In total, 54 different medications were prescribed as duplicates in the study. Pantoprazole, a proton pump inhibitor (PPI), was the most frequently duplicated medication, followed by several cardiovascular drugs, including felodipine, furosemide, and perindopril. The top five most duplicated medications in this study are presented in Table 2

Figure 1 illustrates the distribution of duplicate medication orders by age group. Analysis revealed that duplicate medication orders were most common among patients over 40 years of age.

**Table 1. Baseline characteristics of the samples (n=570)**

| Variables | Frequency (*n*) | Percentage (%) | Mean ± SD |
|---|---|---|---|
| **Gender** | | | |
| Male | 280 | 49.1 | |
| Female | 290 | 50.9 | |
| **Clinic follow-up** | | | |
| Single | 423 | 74.2 | |
| Multiple | 147 | 25.8 | |
| **Number of prescriptions dispensed per year** | | | |
| Two or less | 354 | 62.1 | |
| More than two | 216 | 37.9 | |
| **Age (years)** | | | 42.36 (± 20.90) |

**Table 2. Top five most duplicated medications among patients receiving duplicate medication orders (n=54)**

| Medication | Percentages (%) | Cost (RM) |
|---|---|---|
| Pantoprazole | 21.4 | 151.25 |
| Felodipine | 12.9 | 185.37 |
| Frusemide | 10.0 | 41.00 |
| Perindopril | 10.0 | 10.68 |
| Alfacalcidol | 8.6 | 99.86 |

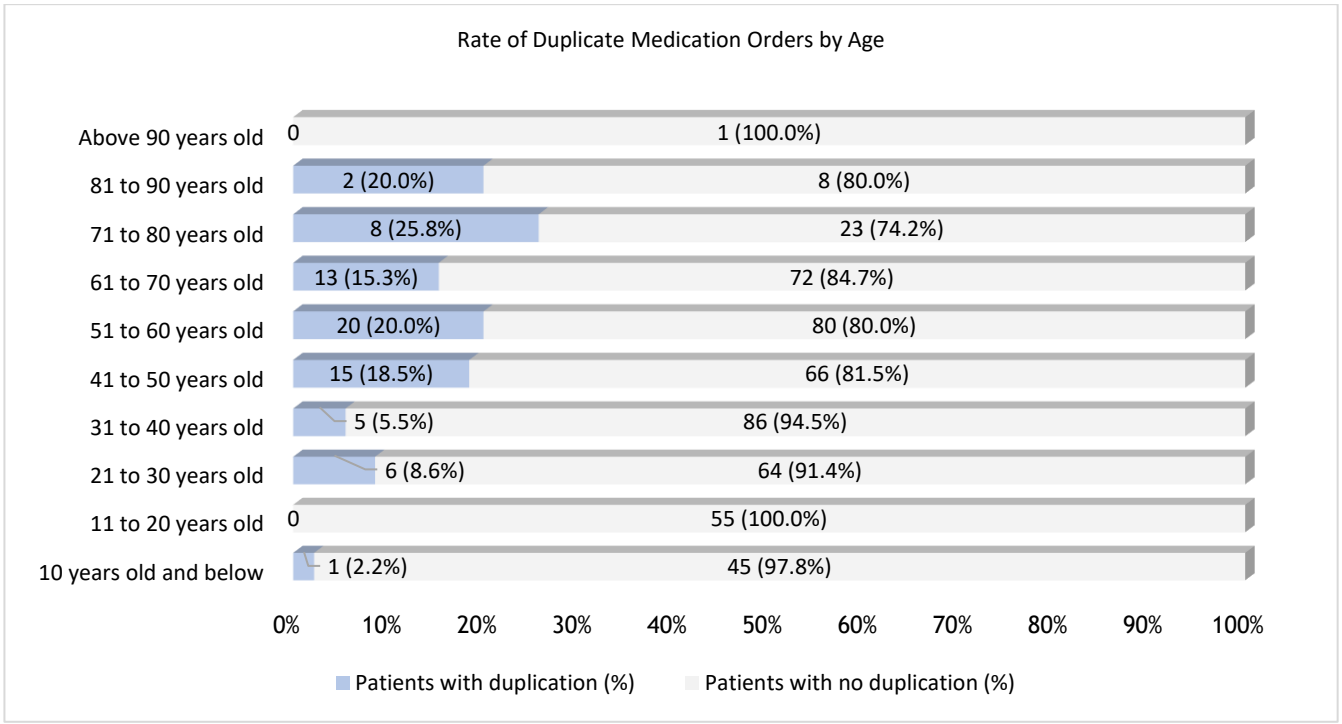


**Figure 1. Duplicate medication orders across age groups (n=570)**

***Factors Associated with Duplicate Medication Orders***

After adjusting for all variables in the multiple logistic regression model, it was found that older age (aOR 1.02, 95% CI 1.00–1.04, P = 0.037), gastrointestinal and hepatobiliary medications (aOR 4.07, 95% CI 1.65–10.07, P = 0.002), and being prescribed more than two prescriptions per year (aOR 9.35, 95% CI 4.21–20.78, P < 0.001) were significantly associated with duplicate medication orders. The odds of duplicate medication orders were 4.07 times higher for patients receiving gastrointestinal medications and 9.35 times higher for those with more than two prescriptions per year. For age, the odds of medication duplication increased by 1.02 times for each additional year of age. Additionally, the Nagelkerke R-squared for the model was 0.353. Table 3 shows the results of the logistic regression analyses for all dependent variables.

***Cost of Duplicate Medication Orders***

Table 4 shows the mean duplication cost per patient for each type of medication found in the study. The mean duplication cost per patient across the six types of medication is approximately RM16.15. Table 5 shows the total cost of duplication reported including the percentage of the cost of duplication to the total drug expense for each type of medication in 2021.

**Table 3. Factors associated with duplicate medication orders**

| Factors | n (%) | | | Simple Logistic Regression | | | | Multiple Logistic Regression | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | With Duplicates ($n_1$ = 70) | Without Duplicates ($n_2$ = 500) | Total Samples ($n$ = 570) | Wald Statistics (df) | Crude OR | 95% CI | *P*-value | Wald Statistics (df) | Adj. OR | 95% CI | *P*-value |
| **Age** | | | | 4.25 (1) | 1.03 | 0.87-2.39 | <0.001* | 4.34 (1) | 1.02 | 1.00-1.04 | 0.037* |
| **Types of Medications Received** | | | | | | | | | | | |
| **Gastrointestinal and Hepatobiliary System** | | | | | | | | | | | |
| Yes | 16 (48.5) | 17 (51.5) | 33 (100) | 31.98 (1) | 8.42 | 4.02-17.62 | <0.001* | 9.26 (1) | 4.07 | 1.65-10.07 | 0.002* |
| No | 54 (10.1) | 483 (89.9) | 537 (100) | | Reference | | | | Reference | | |
| **Cardiovascular System** | | | | | | | | | | | |
| Yes | 28 (29.8) | 66 (70.2) | 94 (100) | 28.38 (1) | 4.38 | 2.55-7.55 | <0.001* | | | | |
| No | 42 (8.8) | 434 (91.2) | 476 (100) | | Reference | | | | | | |
| **Central Nervous System** | | | | | | | | | | | |
| Yes | 9 (13.2) | 59 (86.8) | 68 (100) | 0.06 (1) | 1.10 | 0.52-2.34 | 0.798 | | | | |
| No | 61 (12.2) | 441 (87.8) | 502 (100) | | Reference | | | | | | |
| **Endocrinology and Metabolic System** | | | | | | | | | | | |
| Yes | 17 (31.5) | 37 (68.5) | 54 (100) | 18.07 (1) | 4.01 | 2.12-7.62 | <0.001* | | | | |
| No | 53 (10.3) | 463 (89.7) | 516 (100) | | Reference | | | | | | |
| **Vitamins and Minerals** | | | | | | | | | | | |
| Yes | 12 (18.5) | 53 (81.5) | 65 (100) | 2.55 (1) | 1.75 | 0.88-3.46 | 0.110 | | | | |
| No | 58 (11.5) | 447 (88.5) | 505 (100) | | Reference | | | | | | |
| **Others** | | | | | | | | | | | |
| Yes | 6 (12.2) | 43 (87.8) | 49 (100) | 0.00 (1) | 1.00 | 0.41-2.43 | 0.994 | | | | |
| No | 64 (12.3) | 457 (87.7) | 521 (100) | | Reference | | | | | | |
| **Number of Prescriptions Dispensed per Year** | | | | | | | | | | | |
| More than two | 60 (27.8) | 156 (72.2) | 216 (100) | 52.94 (1) | 13.23 | 6.60-26.53 | <0.001* | 30.08 (1) | 9.35 | 4.21-20.78 | <0.001* |
| Two or less | 10 (2.8) | 344 (97.2) | 354 (100) | | Reference | | | | Reference | | |

**Table 3. Continued**

| Factors | n (%) | | | Simple Logistic Regression | | | | Multiple Logistic Regression | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | With Duplicates ($n_1$ = 70) | Without Duplicates ($n_2$ = 500) | Total Samples ($n$ = 570) | Wald Statistics (df) | Crude OR | 95% CI | *P*-value | Wald Statistics (df) | Adj. OR | 95% CI | *P*-value |
| **Types of Outpatient Specialist Clinics** | | | | | | | | | | | |
| **Orthopedics** | | | | | | | | | | | |
| Yes | 24 (11.9) | 177 (88.1) | 201 (100) | 0.03 (1) | 0.95 | 0.56-1.61 | 0.855 | | | | |
| No | 46 (12.5) | 323 (87.5) | 369 (100) | | Reference | | | | | | |
| **General Medicine** | | | | | | | | | | | |
| Yes | 11 (10.9) | 90 (89.1) | 101 (100) | 0.22 (1) | 0.85 | 0.43-1.68 | 0.849 | | | | |
| No | 59 (84.3) | 410 (87.4) | 469 (100) | | Reference | | | | | | |
| **Surgery** | | | | | | | | | | | |
| Yes | 27 (19.4) | 112 (80.6) | 139 (100) | 8.41 (1) | 2.18 | 1.29-3.68 | 0.004* | | | | |
| No | 43 (10.0) | 388 (90.0) | 431 (100) | | Reference | | | | | | |
| **Pediatrics** | | | | | | | | | | | |
| Yes | 0 (0.0) | 27 (100) | 27 (100) | 0.00 (1) | 0.00 | 0.00-0.00 | 0.998 | | | | |
| No | 70 (12.9) | 473 (87.1) | 543 (100) | | Reference | | | | | | |
| **Psychology** | | | | | | | | | | | |
| Yes | 9 (17.3) | 43 (82.7) | 52 (100) | 1.32 (1) | 1.57 | 0.73-3.38 | 0.250 | | | | |
| No | 61 (11.8) | 457 (88.2) | 518 (100) | | Reference | | | | | | |
| **Otorhinolaryngology** | | | | | | | | | | | |
| Yes | 7 (8.1) | 79 (91.9) | 86 (100) | 1.58 (1) | 0.59 | 0.26-1.34 | 0.209 | | | | |
| No | 63 (13.0) | 421 (87.0) | 484 (100) | | Reference | | | | | | |
| **Obstetrics and Gynecology** | | | | | | | | | | | |
| Yes | 7 (14.6) | 41 (85.4) | 48 (100) | 0.26 (1) | 1.24 | 0.54-2.89 | 0.612 | | | | |
| No | 63 (12.1) | 459 (87.9) | 522 (100) | | Reference | | | | | | |
| **Cardiology** | | | | | | | | | | | |
| Yes | 11 (22.4) | 38 (77.6) | 49 (100) | 4.91 (1) | 2.27 | 1.10-4.68 | 0.027 | | | | |
| No | 59 (11.3) | 462 (88.7) | 521 (100) | | Reference | | | | | | |
| **Endocrinology** | | | | | | | | | | | |
| Yes | 8 (32.0) | 17 (68.0) | 25 (100) | 8.35 (1) | 3.67 | 1.52-8.85 | 0.004* | | | | |
| No | 62 (11.4) | 483 (88.6) | 545 (100) | | Reference | | | | | | |
| **Nephrology** | | | | | | | | | | | |
| Yes | 11 (36.7) | 19 (63.3) | 30 (100) | 14.81 (1) | 4.72 | 2.14-10.41 | <0.001* | | | | |
| No | 59 (10.9) | 481 (89.1) | 540 (100) | | Reference | | | | | | |
| **Clinic Follow-up** | | | | | | | | | | | |
| Multiple | 33 (22.4) | 114 (77.6) | 157 (100) | 17.78 (1) | 3.02 | 1.81-5.05 | <0.001* | | | | |
| Single | 37 (8.7) | 386 (91.3) | 423 (100) | | Reference | | | | | | |

[Δ] *No significant findings from the multicollinearity test and the test for interactions*

**P-value of < 0.05 was considered statistically significant.*

**Table 4. Duplication cost per patient**

| Types of Medications | Cost per patient (RM) |
|---|---|
| Gastrointestinal and hepatobiliary system | 7.55 |
| Cardiovascular system | 10.30 |
| Central nervous system | 17.78 |
| Endocrinology and metabolic system | 17.50 |
| Vitamins and minerals | 2.48 |
| Others (i.e., genitourinary, hormones, allergy, and immune system) | 41.31 |

**Table 5. Cost of duplication and the percentage to total drug expense for each type of medication in 2021**

| Types of Medications | Cost of Duplication (RM) | Total Drug Expense in 2021 (RM) | Proportion (%) |
|---|---|---|---|
| Gastrointestinal and hepatobiliary system | 128.32 | 19568.20 | 0.66 |
| Cardiovascular system | 257.66 | 125304.80 | 0.21 |
| Central nervous system | 142.26 | 52844.93 | 0.27 |
| Endocrinology and metabolic system | 157.51 | 39235.90 | 0.40 |
| Vitamins and minerals | 37.25 | 40829.44 | 0.09 |
| Others (i.e., genitourinary, hormones, allergies, and immune system) | 247.86 | 9554.06 | 2.59 |
| **Total** | **970.86** | **287337.30** | **0.34** |

## DISCUSSION

This is the first study in Malaysia to examine the prevalence of duplicate medication orders and their associated costs. The proportion of duplicates was found to be relatively low, which is encouraging. The Pharmacy Information System (PhIS), implemented in nearly half of the Ministry of Health (MOH) healthcare facilities in Malaysia, offers several benefits. Within a single facility, the system can be used to trace patients' medication history and review current active medication orders, facilitating interventions aimed at reducing duplication at the pharmacy level. However, PhIS has limitations, particularly in its inability to integrate data across different healthcare facilities. Consequently, medication records for patients who visit multiple facilities are not available in PhIS unless the patient brings their manual prescriptions for reference.

This study found that 12.3% of patients had duplicate medication orders, a proportion similar to previous studies reporting rates of 8.8% and 11.1%.[4,5] Variations in these proportions could be attributed to differences in sampling methods, inclusion criteria, definitions of medication duplication, and detection techniques. As noted by Zahari, previous studies in Malaysia did not document the overall rate of medication duplication, and Zahari's own study focused on duplications of a single medication.[9] Therefore, direct comparisons with prior local studies are limited.

Pantoprazole, a proton pump inhibitor (PPI), was found to have the highest duplication rate in this study, a finding consistent with a study conducted in India among hospital ward patients.[21] It was suggested that the over-prescription of PPIs to prevent gastrointestinal side effects without proper indications contributed to this high duplication rate.[8] The study highlighted frequent PPI prescriptions for patients with cardiovascular or gastrointestinal comorbidities. However, when these patients visited the emergency department for acute gastrointestinal symptoms, PPIs were often prescribed again. A similar pattern was observed in hospital ward patients, who were discharged with overlapping PPI prescriptions from outpatient clinics. Although PPIs are generally considered low-risk medications, studies have shown they can lead to significant cardiovascular, renal, and neurological complications when used inappropriately.[22,23] Several studies have emphasized the prevalence of inappropriate PPI use in Malaysia, highlighting the urgent need for clear guidelines on appropriate PPI prescribing in the local context.[24,25]

The study also found that the likelihood of medication duplication increased with age, consistent with the higher prevalence of multimorbidity in older populations. Multimorbidity often results in polypharmacy, which can increase the risk of duplicate prescriptions. Patients aged 71 to 80 years had the highest percentage of duplicate medication orders, which aligns with findings from previous studies on older adults.[26-28] However, other studies have reported higher rates of medication duplication, especially for over-the-counter medications like cough and cold remedies in patients younger than 20 years.[5] Since this study focused on patients from Outpatient Specialist Clinics and HDU, its findings primarily reflect duplication patterns for chronic or long-term medications.

The number of prescriptions dispensed per patient over a year emerged as a significant factor contributing to medication duplication in this study. It is logical that as the number of prescriptions increases, so does the likelihood of duplication. PhIS is currently used only in the pharmacy department, and prescribers have limited access to patients' full

medication histories during the prescribing process. This study suggests that extending the use of PhIS beyond the dispensing stage could help prevent duplication. Some MOH institutions have already introduced the use of PhIS by prescribers to review patients' medication profiles, but this practice is not yet widespread due to resource limitations such as insufficient computers, equipment, and training. Therefore, improving access to PhIS and promoting its use by prescribers could be an important step toward reducing medication duplication.

Contrary to previous studies that identified alert fatigue as a barrier to effective error reduction measures, this study found that the PhIS system lacked effective alerts for duplicate prescriptions. [29] For instance, the system did not issue alerts when medications from similar drug classes were ordered together. To address this, more comprehensive, evidence-based system alerts should be developed to avoid overwhelming users with pop-ups that are frequently ignored or overridden.[29]

In addition to improving the system, the role of pharmacists as gatekeepers for appropriate medication dispensing should be strengthened. This includes clarifying medication indications, providing information on patients' previous medication history, and enhancing medication reconciliation processes to reduce duplication.

The total cost of duplicate medications in this study accounted for 0.34% of the total drug expenditure in 2021. In contrast, Kinoshita et al. found higher duplication costs, with proportions of 0.5% for lower-priced medications and 0.7% for higher-priced ones.[5] The lower duplication cost in this study could be explained by the exclusion of certain medications (e.g., drops, sprays, and topical formulations) and the use of mostly generic drugs.

Previous studies have compared the cost-effectiveness of paper-based versus computerized electronic medication ordering systems, with some suggesting that the additional costs of electronic systems are justified. For instance, Vermeulan et al. found an Incremental Cost-Effectiveness Ratio (ICER) of 3.54 to prevent one medication error, concluding that the extra cost of using electronic systems was acceptable.[30]

However, the current PhIS ecosystem limits direct comparisons with previous pharmacoeconomic studies, as it operates within a dual-recording system where medical records and prescriptions are still paper-based. Once prescriptions are received by the outpatient pharmacy, PhIS is used to transcribe them electronically. Given that nearly half of MOH facilities now use PhIS, more pharmacoeconomic studies are needed to evaluate the cost-effectiveness of this system.

This study has several limitations. First, the data collected was limited to secondary data extracted from patient registry and PhIS system. Second, duplicate medication orders identified in this study do not necessarily translate into adverse clinical outcomes. The clinical implications of these duplicates are speculative, as confirming double-dose administration would require patient interviews. Additionally, there was no method to distinguish between intentional and unintentional duplication by prescribers. Finally, as this was a single-center study conducted at a district hospital, the findings may be conservative, and the proportion of duplicate medication orders may be underestimated, especially when considering duplications across different healthcare institutions.

## CONCLUSION

This study found that the rate of duplicate medication orders was relatively low, which reflects positively on the current PhIS system used at the hospital. This finding supports the recommendation to further enhance the system and expand its implementation to other MOH facilities that still rely on manual processes. Since this study was conducted in a district hospital in Jerantut, expanding similar research to other tertiary hospitals with higher patient volumes in Malaysia could help assess the cost-effectiveness of the PhIS system in detecting medication duplications. Additionally, further studies comparing duplication rates across different healthcare facilities are needed to better understand the broader impact. Such research would not only promote patient safety but also contribute to long-term cost savings in national healthcare expenditure.

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## CONFLICT OF INTEREST

The authors declare no conflict of interest.

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## ETHICAL APPROVAL

This study was approved by the IMU Joint Committee on Research and Ethics and the Medical Research and Ethics Committee (MREC), Ministry of Health Malaysia. It was conducted in compliance with ethical principles outlined in the Declaration of Helsinki and the Malaysian Good Clinical Practice Guideline. In the data collection form, patients' details, such as their names and National Registration Identification Numbers, were de-identified and new code numbers were given to each patient. The data collected was kept private and confidential.

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