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Prescription errors in patients with systemic sclerosis: Exploratory data analysis from scleroderma clinic

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Abstract

Systemic sclerosis (SSc) is a systemic autoimmune disease characterized by fibrosis, inflammation, and vasculopathy. Treatments aiming to manage all pathologic processes and polypharmacy may inevitably increase the likelihood of prescription errors. We aimed to quantify the numbers of prescription errors and identify factors associated with prescribing errors among SSc patients at the Scleroderma Clinic from January 2016 to December 2022. Prescription error was defined as any modification or cancellation of a medication in the prescription, excluding logistic issues. Among 9,741 prescriptions, 199 (2%) were prescription errors. The most common type of prescription error was duplicated medication (50.5%), followed by prescribed incorrect amount of medicines (34.2%), improper dosage regimen (5.6%), improper drug selection (5.1%) and a history of adverse drug reaction (4.6%). Immunosuppressants and vasodilators were frequently modified and canceled due to their serious side effect history. Neither physician experience nor the types of medication were associated with the occurrence of prescription errors. While the overall rate of prescription errors in the Scleroderma Clinic was low, duplicated medication was the most prevalent type. Implementing strategies targeting these errors could potentially reduce their incidence.

Keywords: systemic sclerosis, scleroderma, medication, prescription errors, prescription modifications, prescription cancellations

1. Introduction

Systemic sclerosis (SSc), or scleroderma, is a systemic autoimmune disease in which fibrosis, inflammation, and vasculopathy are features of the disease [1]. The pathology commonly affects skin and also internal organs. When disease affects both internal organs and the vascular system, anti-inflammatory medications including immunosuppressants as well as vasodilator drugs, are commonly prescribed to control the symptoms and stop the progression of the disease [2]. Therefore, polypharmacy may inevitably be involved, and prescription error might occur. Prescription errors can have significant adverse effects on patient outcomes. By understanding and identifying the types and frequency of these errors, targeted strategies can be implemented to reduce the incidence and improve patient safety and quality of care [3].

Scleroderma clinic in Srinagarind Hospital is a specialized clinic providing comprehensive and holistic care for SSc patients. The attending physicians in the clinic include expert rheumatologists, young rheumatologists, fellows of rheumatology, and postgraduate training doctors who rotate to the clinic every four weeks. The treatments are currently all prescribed through a window application connected with a relational database named “Health Object” (HO). Renewing prescriptions can be easily performed by including previous prescriptions from the HO system or updating the prescription to the current visit. Almost all rheumatologists are familiar with immunosuppressants and vasodilator prescriptions, while non-rheumatology experts might have less experience making the initial prescription or even renewing one. The roles of pharmacists in the Scleroderma Clinic in daily practice were to screen the prescriptions, detect unclear prescriptions, give feedback to the prescribers and then modify or cancel

the medications in the HO system. The system also provides alerts for drug allergies and shows the previous medications to compare to the current prescription. As not all potentialities are alerted, pharmacists check the quantity of the medicine manually. Some prescription errors are detected by speaking to patients, such as side effects or allergies that were not entered into the support system. Pharmacists also check every prescription for administrative correctness, pharmaco-therapeutic appropriateness and they modify the prescriptions after consulting the prescriber.

Pharmacists play a crucial role in detecting and correcting prescription errors [3]. Pharmacists therefore have a role in the medical prescription process in order to ensure patient safety. The process is a) detect unclear or prescription error; b) notify the doctor who made the prescription error; and c) modify the prescription. Ideally, prescription errors should not happen, or occur as seldom as possible. However, prescription error is still detected in daily practice in the Scleroderma Clinic particularly for immunosuppressants which are harmful and should be used with caution. In addition, SSc patients often require complex medication regimens including immunosuppressants and vasodilators, these regimens are prone to errors. Research in this area can help develop better protocols and training programs to enhance the effectiveness of pharmacists' interventions, ensuring that prescriptions are accurate and appropriate [4]. So, we would like to explore the numbers of prescription errors and describe the factors associated with the errors at the Scleroderma Clinic. If factors associated with the errors are defined, the modality that acts on those factors might decrease the rate of prescription error.

2. Materials and methods

A retrospective study was conducted by reviewing prescriptions from the Scleroderma Clinic, Srinagarind Hospital, Khon Kaen University, Khon Kaen, Thailand, between January 2016 and December 2022. The prescriptions were extracted from the window application connected with a relational database named "Health Object" (HO). We included prescription errors from the attending doctors in Scleroderma Clinic and the prescriptions were extracted from the HO system using the term "Modified prescription". We excluded the prescription errors caused by logistic issues such as unavailability of medical stock (out of stock) and the errors caused by brand changes according to the hospital policy. The data extracted from the HO system included patients' sex, date of birth, date of prescription error, medication name, attending physician (who made the prescription error and then they were categorized by expertise and level of education/seniority), and types of prescription error. The documented prescription errors were based on prescription error reports from the HO system.

2.1 Operational definitions

Prescription errors were categorized according to a hospital-based definition into the following categories: a) need for additional therapy; b) improper drug selection; c) improper dosage regimen; d) adverse drug reaction or side effect; e) drug interaction; f) unnecessary drug therapy; g) duplicate/repeat medication; and h) other errors.

Need for additional therapy was defined as, for example, when there was a failure to receive medication prophylaxis, such as when doctors prescribe methotrexate (MTX) without prescribing folic acid, which can help decrease the side effects of folate deficiency. Many patients treated with MTX experience mucosal, gastrointestinal, hepatic, or hematologic side effects, and supplementation with folic acid during treatment with MTX may ameliorate these side effects [5].

Improper drug selection was defined as the ordering of the wrong medicine or product, prescribing an inappropriate dosage form, or using a medication despite contraindications.

Improper dosage regimen was defined as an incorrect strength or dosage of the medicine, such as when the dose was too low or too high, or when the interval for taking of medication in the prescription was too short or too long.

Adverse drug reaction or side effect was defined as the inclusion of medicines that had previously caused documented adverse drug reaction(s).

Drug interaction was defined as a reaction between two or more drugs that can affect how a drug works or cause unwanted side effects.

Unnecessary drug therapy was defined as the prescription of a therapy that had already been discontinued.

Duplicate or repeat medication was defined as the presence of two orders of the same drug in the same prescription.

Other errors included prescribing the wrong number of medications, among others.

An expert rheumatologist was defined as a rheumatologist who had practiced in rheumatology for at least five years. A young rheumatologist was defined as a rheumatologist who had practiced in rheumatology less than five years.

2.1 Statistical analysis

Descriptive statistics were used to report data. The continuous data were displayed as appropriate as mean ± standard deviations (SD) or medians and interquartile ranges (IQR). The prescription error rate was determined with a 95% confidence interval (95%CI). The categorical data were displayed as proportions or percentages. The factors associated with prescription errors were investigated using Chi-square test for categorical dependent variables and student t-test or Wilcoxon Sign Rank for continuous data as appropriate.

3. Results and discussion

A total of 9,741 prescriptions from the Scleroderma Clinic during study period were reviewed, of which 199 were defined as prescription errors with the rate of prescription error being 2.04% (95%CI 1.8-2.3). The most common type of prescription error was duplicated medication (50.5%), followed by prescribed incorrect amount of medicines (34.2%), improper dosage regimen (5.6%), improper drug selection (5.1%) and history of adverse drug reaction(s) (4.6%). (Figure 1) Examples of prescription error are shown below (Table 1)

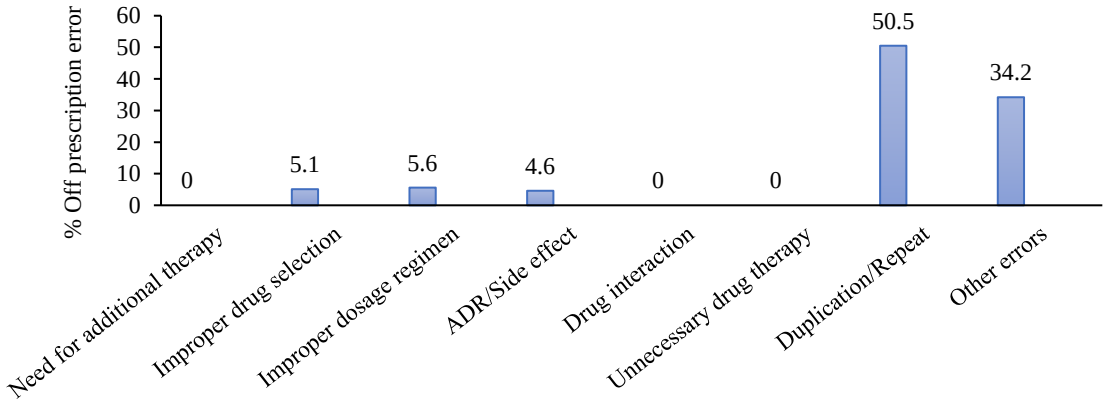

Figure 1 Types of prescription errors.
ADR; adverse drug reaction.

Table 1 Types of prescription errors.

Type of error	Example of prescription error	
	Reasons	Actions
Improper drug selection		
- Inappropriate dosage form	Prescribed antacid tablet only 3 tablets	Consulted prescriber for dosage form and changed to Antacid gel® 3 bottles
Improper dosage regimen		
- Too low dose	Incorrect dosage of ofloxacin was prescribed	Dose adjustment from ofloxacin 100 mg to ofloxacin 200 mg according to dosage regimen of complicated UTIs for adult
- Too high dose	Exceed maximum dose of Amlodipine (10mg/day)	After consulting prescriber, changed from amlodipine to manidipine
- Too short/long interval	Clotrimazole for oropharyngeal slowly dissolved in mouth 1 time daily	Consulted prescriber and adjusted to 3 times daily
ADR/Side effect		
- Side effect	Nifedipine immediate release was prescribed, but the patient got hypotension from this dosage form	Substituted to nifedipine sustained release
Allergy/hypersensitivity	Amoxycillin/clavulanic was prescribed, despite there being a record of penicillin intolerance	Substituted to azithromycin
Duplication/Repeat	Prednisolone was sent electronically twice	Canceled the double prescription
Other (prescribed incorrect amount of medicines)	Prescribed sildenafil was not enough for the next visit	Adjustment of the number of tablets

ADR; adverse drug reaction.

When categorizing the prescription errors by prescribers, the most common prescription errors were revealed to be from fellows of rheumatology (90 errors), followed by expert rheumatologists (87 errors), internists under the supervision of expert rheumatologists (17 errors), and young rheumatologists (2 errors). For the frequency of prescription errors, there is no statistically significant difference between groups of doctors in The Scleroderma clinic, which were categorized into four groups by experience in The Scleroderma clinic. The most common type of prescription error was duplicated medication by all prescribers. However, the frequency of the prescription errors in each type of error was not different among prescribers by statistical analysis (Table 2)

Table 2 Frequency of prescription errors categorized by prescribers.

Type of prescription error	Expert rheumatologists N = 87	Young rheumatologists N = 2	Fellow of rheumatology N = 90	Internists N = 17	p-value
Need for additional therapy	0	0	0	0	NA
Improper drug selection	6 (6.9)	0	3 (3.3)	1 (5.9)	0.52
Improper dosage regimen	5 (5.8)	0	6 (6.7)	0	0.83
ADR/Side effect	3 (3.4)	1 (50.0)	4 (4.4)	1 (5.9)	0.14
Drug interaction	0	0	0	0	NA
Unnecessary drug therapy	0	0	0	0	NA
Duplication/Repeat	44 (50.1)	1 (50.0)	45 (50.0)	9 (52.9)	0.99
Other (prescribed incorrect amount of medicines)	29 (33.3)	0	32 (35.6)	6 (35.3)	0.95

NA; data not available due to statistical limitation, ADR; adverse drug reaction 3 prescriptions had no recorded prescriber.

The average age of the patients who received prescription error was 58±10.6 years. There was no statistically significant difference between age groups among prescribers (p=0.06).

When prescription error were categorized by immunosuppressants, disease modifying rheumatic drugs (DMARDs), and vasodilators which can cause serious adverse reactions, the prescription errors were 50 out of 199 prescriptions (0.5%) for all prescriptions. Hydroxychloroquine, chloroquine, cyclophosphamide, mycophenolate mofetil, methotrexate, prednisolone, and sildenafil were considered frequent prescription modifications and cancellations because of their serious side effects. The prescription errors of immunosuppressants, DMARDs, and vasodilators are presented in Table 3.

Table 3 Prescription errors of immunosuppressants and vasodilators.

Drugs	Prescription error		
	Total	Drug modification	Drug cancellation
	N	*N (%)*	*N (%)*
MMF(Cellcept®) 250 mg	2	1 (50.0)	1 (50.0)
MMF(Cellcept®) 500 mg	1	0	1 (100.0)
MMF(Immucept®) 250 mg	3	1 (3.33)	2 (66.7)
Chloroquine 250 mg	1	0	1 (100.0)
Cyclophosphamide 50 mg	7	4 (57.1)	3 (42.9)
HCQ(Hydroquin®) 200 mg	6	4 (66.7)	2 (33.3)
HCQ(Quinnel®) 200 mg	2	1 (50.0)	1 (50.0)
Methotrexate 2.5 mg	2	2 (100.0)	0
Prednisolone 5 mg	15	4 (26.7)	11 (73.3)
Sildenafil (GPO®) 20 mg	1	0	1 (100.0)
Sildenafil (Silatio®) 20 mg	2	2 (100.0)	0
Sildenafil (Sildegra®) 50 mg	8	4 (50.0)	4 (50.0)
Total	50	23	27

MMF; mycophenolate mofetil, HCQ; hydroxychloroquine, GPO; the Government Pharmaceutical Organization.

This study described the rate of prescription errors in SSc patients from the Scleroderma Clinic. The Scleroderma Clinic is a specialty clinic that includes only SSc patients across various disease severities, ranging from early onset SSc to long-duration SSc. All patients underwent clinical assessment and disease severity evaluation, with medical adjustments made by specialists or under their supervision. Despite being a specialty clinic where almost all patients are evaluated by specialists, prescription errors still occur. However, the rate of prescription errors in SSc patients is low and deemed acceptable.

Duplicate or repeat medication was the most common type of error for all prescribers. This might be explained by a system defect. Improving the rate of errors should involve managing the health information technology (health IT) system to provide notification in case of duplication for all kinds of medicine. These findings align with previous results, suggesting that duplicate medication orders have become a notable type of medication error following the implementation of computerized provider order entry [6]. Health IT is known to reduce prescribing errors but may also cause new types of technology-generated errors related to data entry, duplicate prescribing, and prescriber alert fatigue [7]. Despite existing health IT, duplicate medication order errors persist. Enhancements can be achieved by gaining a deeper understanding of the context surrounding these errors and contributing factors. However, healthcare facilities may need to gather additional information to obtain these insights. Recommendations include conducting an in-depth analysis of health IT systems [6].

No error was observed regarding the necessity for additional therapy or unnecessary drug regimens. This can be attributed to the comprehensive prescriptions provided to SSc patients, including vasodilators (for Raynaud's phenomenon and/or pulmonary arterial hypertension), acid suppression, prokinetic drugs (for gastrointestinal involvement), immunosuppressants (for skin thickness and cardiopulmonary involvement), and steroids, which also include medication for osteoporosis prevention and treatment. Consequently, patients no longer require additional medicine or unnecessary drug therapy. In addition, the health IT system is configured to assist prescribers in re-prescribing medication easily by incorporating previous prescriptions and updating them for the current visit. The health IT system also includes prescriber alerts, thus reducing prescribing errors across various hospital settings [7].

The most common prescription errors were made by fellows of rheumatology. Fellows of rheumatology in our clinic are postgraduate trainees who work temporarily at the hospital. They may not be familiar with the HO system, which could lead to multiple prescription errors, especially duplicate medication. Additionally, they may have limited experience in prescribing medication for rheumatologic diseases, resulting in improper drug selection, improper dosage regimen, and/or incorrect numbers of medications being prescribed. The same findings were also reported in the study by Leviatan, et al. The authors revealed that insufficient experience in prescribing a specific drug was significantly linked to an increased risk of error [8]. The action plan should include strict orientation and supervision during prescribing. Interestingly, expert rheumatologists exhibited similar types of errors to fellows of rheumatology, with slightly higher rates of improper drug selection compared to other groups. In our clinic, the expert rheumatologists handled a larger number of patients compared to young rheumatologists, fellows of rheumatology, and internists. Moreover, they had to supervise internists in the clinic and were frequently interrupted by consultations from internists outside the clinic. Consequently, they may not have been able to focus entirely on prescriptions, resulting in prescription error. These findings confirm previous results indicating that physicians' workload, as determined by the number of medications prescribed during a shift, was associated with an increased risk of error [8].

We aimed to eliminate prescription errors for immunosuppressants, DMARDs, and vasodilators in the Scleroderma Clinic, as they could lead to serious complications if overdosed. However, prescription errors for these medications were observed. Although the number of errors were low (50 out of 199 prescription errors), such errors could result in serious complications, such as bone marrow suppression, if duplicate prescriptions or excessively high doses are given. To prevent the risk of prescription errors involving immunosuppressants, DMARDs, and/or vasodilators, safety concerns must be incorporated into a risk management plan and all prescriptions for those medications should be routinely double-checked by the pharmacist team or medical staff before being dispensed [9].

The strengths of this study included being the first study to investigate prescription errors treating SSc—an autoimmune disease—and to assess errors involving immunosuppressants, DMARDs, and vasodilators, all of which are known to carry serious adverse events. However, limitations included the lack of recorded coexisting comorbid diseases and the absence of outcomes of patients who received these prescription errors. Our findings may offer several insights to help pharmacists improve care for SSc patients. First, addressing prescription errors can reduce the risk of adverse drug reactions and side effects. This may enhance patient safety. Second, understanding the causes and factors leading to prescription errors allows healthcare providers to refine prescribing processes and systems, leading to more accurate and appropriate medication use. Third, findings for this study can be used to develop educational programs and training for physicians and/or healthcare professionals, improving their knowledge and skills in prescribing medication and managing prescription errors. Finally, accurate prescriptions may improve patient satisfaction with their healthcare and can lower the costs associated with drug related complications.

4. Conclusion

The study quantified prescription errors among SSc patients, finding that the rate of prescription error was low in the Scleroderma Clinic, but duplicated medication was the most common type of prescription error. Immunosuppressants and vasodilators were frequently modified or canceled due to their serious side effects. Neither the experience of the physicians nor the types of medication prescribed were associated with the occurrence of prescription errors. Implementing interventions targeting these errors could potentially reduce the overall incidence rate of prescription errors.

5. Acknowledgement

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6. Conflict of interests

All authors declare that they have no conflict of interest.

7. Ethical approval

The Human Research Ethics Committee of Khon Kaen University reviewed and approved the study as per the Helsinki Declaration and the Good Clinical Practice Guidelines (HE661079). The need for informed consent was waived by The Human Research Ethics Committee of Khon Kaen University.

8. References

[1] Stern EP, Denton CP. The pathogenesis of systemic sclerosis. Rheum Dis Clin North Am. 2015;41(3):367–382.
[2] Kowal-Bielecka O, Fransen J, Avouac J, Becker M, Kulak A, Allanore Y, et al. Update of EULAR recommendations for the treatment of systemic sclerosis. Ann Rheum Dis. 2017;76(8):1327–1339.
[3] Alzahrani AA, Alwhaibi MM, Asiri YA, Kamal KM, Alhawassi TM. Description of pharmacists' reported interventions to prevent prescribing errors among in hospital inpatients: a cross sectional retrospective study. BMC Health Serv Res. 2021;21(1):432.
[4] El Aoufy K, Melis MR, Iovino P, Bambi S, Lorini C, Bonaccorsi G, et al. The rising challenge of poor health literacy of patients with systemic sclerosis: Preliminary data identify important unmet needs in an italian cohort. Nurs Rep. 2024;14(1):556-565.
[5] Shea B, Swinden MV, Tanjong Ghogomu E, Ortiz Z, Katchamart W, Rader T, et al. Folic acid and folinic acid for reducing side effects in patients receiving methotrexate for rheumatoid arthritis. Cochrane Database Syst Rev. 2013;2014(5):CD000951.
[6] Bocknek L, Kim T, Spaar P, Russell J, Busog D-N, Howe J, et al. Duplicate medication order errors: Safety gaps and recommendations for improvement. Patient Saf. 2022;4(3):39-47.
[7] Devin J, Cleary BJ and Cullinan S. The impact of health information technology on prescribing errors in hospitals: A systematic review and behaviour change technique analysis. Syst Rev. 2020;9(1):275.
[8] Leviatan I, Oberman B, Zimlichman E, Stein GY. Associations of physicians' prescribing experience, work hours, and workload with prescription errors. J Am Med Inform Assoc. 2021;28(6):1074–1080.
[9] Hoeve CE, Francisca RDC, Zomerdijk I, Sturkenboom MCJM, Straus SMJM. Description of the risk management of medication errors for centrally authorised products in the european union. Drug Saf. 2020;43(1):45–55.