Saudi Pharmaceutical Journal 30 (2022) 1101–1106

Contents lists available at ScienceDirect

Saudi Pharmaceutical Journal

journal homepage: www.sciencedirect.com

Original article

# The impact of clinical pharmacist implemented education on the incidence of prescribing errors in COVID-19 patients

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ARTICLE INFO

*Article history:*
Received 14 July 2021
Accepted 11 June 2022
Available online 15 June 2022

*Keywords:*
Clinical pharmacist
Education
Prescribing errors
COVID-19

ABSTRACT

*Background:* Clinical pharmacists have a vital role during COVID-19 pandemic in mitigating medication errors, particularly prescribing errors in hospitals. That is owing to the fact that prescribing errors during the COVID-19 pandemic has increased.
*Aim:* This study aimed to evaluate the impact of the clinical pharmacist on the rate of prescribing errors on COVID-19 patients in a governmental hospital.
*Methods:* The study was a pre-post study conducted from March 2020 till September 2020. It included the pre-education phase P0; a retrospective phase where all the prescriptions for COVID-19 patients were revised by the clinical pharmacy team and prescription errors were extracted. Followed by a one-month period; the clinical pharmacy team prepared educational materials in the form of posters and flyers covering all prescribing errors detected to be delivered to physicians. Then, the post-education phase P1; all prescriptions were monitored by the clinical pharmacy team to assess the rate and types of prescribing errors and the data extracted was compared to that from pre-education phase.
*Results:* The number of prescribing errors in P0 phase was 1054 while it was only 148 in P1 Phase. The clinical pharmacy team implemented education phase helped to significantly reduce the prescribing errors from 14.7/1000 patient-days in the P0 phase to 2.56/1000 patient-days in the P1 phase (p-value <0.001).
*Conclusion:* The clinical pharmacist significantly reduced the rate of prescribing errors in patients with COVID-19 which emphasizes the great role of clinical pharmacists' interventions in the optimization of prescribing in these stressful conditions.


## 1. Background

Corona virus disease 19 (COVID-19) is a global pandemic started in December 2019 in Wuhan City, China (Esakandari et al., 2020). It is caused by severe acute respiratory syndrome coronavirus 2 (SARS-COV-2) that can be transmitted from human to human through direct contact with infected patients (Sun et al., 2020). Around 50–70% of patients with positive swab are asymptomatic while others can have symptoms like mild flu-like symptoms and in 10% of the patients, symptoms are severe including dyspnea, interstitial pneumonia, acute respiratory distress syndrome, and respiratory and multiorgan failure with estimated 5% mortality rate (Pascarella et al., 2020). Up till now, there is no definitive treatment for COVID-19 disease. Management is mainly

*Abbreviations:* COVID-19, Corona virus disease 19; PE, Prescribing error; CPs, Clinical pharmacists; ICU, Intensive care unit.

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Peer review under responsibility of King Saud University.

Production and hosting by Elsevier

https://doi.org/10.1016/j.jsps.2022.06.007
1319-0164/

based on supportive medications including antiviral agents, some antibiotics, anti-inflammatory agents, vitamins and anticoagulant prophylaxis agents (Jean et al., 2020).

Medication errors can be defined as "an unintended failure in the drug treatment process that leads to, or has the potential to lead to, harm to the patient" that can occur at any stage from prescribing till administration (Goedecke et al., 2016). It is estimated that medication errors can cause the death of 1 of 131 as well as 1 of 854 of outpatient and inpatient respectively (Wittich et al., 2014). In a systematic review, it has been reported that a single error can cost an average of €2.58 to €111727.08 (Walsh et al., 2017). Prescribing error (PE) is a common type of medication errors that can be attributed to poor knowledge, illegible handwriting, inadequate training and documentation (Coleman, 2019). The rate of PE has been reported to occur 8.8 times per 100 medication orders. The most common PE types are incomplete information followed by unnecessary drug and wrong dose (Lavan et al., 2016). Many studies have shown that clinical pharmacist implemented educational programs can significantly reduce PEs (Abuelsoud, 2019; Agrawal et al., 2009; Irajpour et al., 2019; Li et al., 2013; Winder et al., 2015).

The importance of clinical pharmacists (CPs) can be shown in efforts to minimize medication errors, particularly in the hospital setting (Fernández-Llamazares et al., 2012; Kessemeier et al., 2019; Khalili et al., 2011; Vessal, 2010). Moreover, CPs have a crucial role in preventing PEs before reaching patients (Farmer et al., 2018; Patanwala et al., 2012). There is substantial evidence to demonstrate that pharmacists impact medication safety worldwide (Dale et al., 2003; Kessemeier et al., 2019) Therefore, the involvement of such highly trained clinical pharmacists could improve patient care. Nevertheless, no studies have examined clinical pharmacy contributions in detecting the presence of PEs during the current COVID-19 pandemic.

Since the development of COVID-19, there has been a tremendous amount of information about treatment and diagnostic choices for COVID-19 patients based primarily on preliminary experience on retrospective studies or small case studies (Galluccio et al., 2020). Moreover, patients who are suffering from COVID-9, usually receive complex list of medications based on their clinical condition with treatment strategies including medications that are not commonly used in practice (Barlow et al., 2020). With respect to the severity of clinical presentation and level of organ damage, there is a huge diversity in patients with COVID-19. In addition and during the pandemic, physicians are burdened by time pressure, long working hours and emotional stress (Galluccio et al., 2020; Morgantini et al., 2020). Moreover, they face many other challenges including unpreparedness, high adversity, fear of infections and fear about their families, high level of anxiety and depression as a psychological consequence and poor organizational support (Morgantini et al., 2020; Zerbini et al., 2020). All these factors can increase the risk of medication errors. All these circumstances increase the probability of prescribing errors. Therefore, clinicians are required to maintain high state of alertness during this pandemic (Heath et al., 2020). Hence, the objective of the current study was to detect the rate of PEs as the number/1000 patient-days for admitted patients with COVID-19. Furthermore, this study aimed to evaluate the role of clinical pharmacist implemented education on the rate of PEs.

## 2. Methods

### 2.1. Study design and setting

This study was a pre-post study conducted at a governmental hospital in Egypt over 7 months from March 2020 to September 2020. During this period, the hospital was only admitting COVID-19 patients. The study was divided into 3 phases; retrospective pre-education control phase (P0), educational phase and finally prospective intervention active phase (P1).

#### 2.1.1. The retrospective pre-education control phase (P0)

All prescriptions of the hospitalized and intensive care unit (ICU) patients were collected by the clinical pharmacy team over a period of 3 months. The prescriptions were revised based on the patient's information extracted from patient's file. Prescribing errors were extracted and were classified into wrong drugs, inappropriate dosing regimen, incomplete instructions, medication with no indication (the patient is using a medication for a non-medical cause), indication without medications, lack of monitoring recommendation and others including drug duplication, illegible handwriting and drug interactions. The rate of PEs was represented as the number/1000 patient-days and the percentage of each category was also calculated.

#### 2.1.2. Clinical pharmacist implemented education

All PEs were collected, analyzed and educational materials about these errors were prepared by the clinical pharmacy team. Since educational meetings and gatherings were not allowed because of the pandemic's safety measures issued, educational materials were delivered to the physician in the form of flyers, posters with all types of observed medication errors hanged in different department and in prescribers' rooms. In-site personal education, and verbal communication through phone calls were carried out. Moreover, online educational meetings for sharing experiences, online weekly educational meeting with the participation of clinicians, and the distribution of clinical protocols and guidelines. The education program covered 22 physicians including 7 ICU physicians, 10 internal medicine physician and 5 emergency room physicians.

#### 2.1.3. The prospective post-education phase (P1)

Phase P1 was a 3-month prospective phase similar to the pre-education phase. All prescriptions were monitored by the clinical pharmacy team and PEs were collected, classified, and presented in the same manners of the pre-education phase. Data from this phase were compared to the retrospective phase to evaluate the impact of the education of the rate of PEs. As part of the pharmacists' daily responsibilities, they took turns participating in educational activities and implementing organized interventions to help identify, solve, and prevent PEs. Physicians and pharmacists were aware of each other and their advice was taken into consideration. Every day, the team met to revise the care plan, which they ultimately decided on (Bergkvist Christensen et al., 2011). The pharmacist brought this up with the physicians at a meeting throughout P1 to identify, prevent, and resolve PEs.

### 2.2. Statistical analysis

Numerical data were presented as median and ranges while categorical were presented as frequency and percentages. Comparison between the two rates was done assuming Poisson distribution. The test used was a Chi-square test based method. Other comparisons were done using SPSS package version 22. The data were tested for normality using Kolmogorov and Shapiro Wilk tests and were found to be non-parametric. Comparisons between the two phases with respect to numeric data were done using Mann Whitney test while comparisons for categorical data were done using Fischer Exact test. All p-values were two sided and p-values < 0.05 were considered significant.

The rate of prescribing errors was represented as the number/1000 patient-days and the percentage of each category was also calculated according to the following equation (Laher et al., 2021; Leape et al., 1999; Wilmer et al., 2010):

$$\text{Rate of PEs} = \frac{\text{total number of errors detected}}{\text{total number of partients in the phase x duration of the phase (days)}} \times 1000$$

## 3. Results

The study flowchart is presented in Fig. 1. From March 2020 to September 2020, around 2097 prescriptions were revised for 1436 patients including 794 and 642 patients in the pre-education and post-education phases respectively. Prescribing errors were reported for 469 patients with median age of 62 (range: 19–88) in P0 phase and 122 patients in P1 phase with median age of 60 (rang: 19–84). The ICU patients represented 18.3% (86 out of 469) in P0 phase compared to 15.6% (19 out of 122) in P1 phase (p-value = 0.477).

### *3.1. Rate of prescribing errors*

The number of PEs in P0 phase was 1054 while it was 148 in P1 phase. The clinical pharmacist implemented education significantly reduced the PEs from 14.7/1000 patient-days in P0 phase to 2.56/1000 patient-days in P1 phase (p-value <0.001).

### *3.2. Classification of prescribing errors*

Classes of medications involved in PEs were antibiotics, analgesics antipyretics, antiplatelet/anticoagulants, vitamins, steroids, bronchodilators, anti-cytokine medications including tocilizumab and hydroxychloroquine and others. Classification of types of PEs errors in the two phases are summarized in Table 1. Using Fischer Exact test, there was a significant difference between the two phases regarding classification of PEs. The most common class encountered in PEs was antibiotics contributing to 250 PEs in the phase P0, 47.6% of them was related to medication without indications. In the P1 phase, antibiotics accounted for only 39 PEs, 43.5% of them was medication without indication.

Data presented in Table 2 showed that the most frequent type of PEs in the pre-education phase P0 was inappropriate dosing regimen, with a frequency of 486 errors. Most of the inappropriate dosing regimen in the P0 phase involved the use of vitamins accounting for 141 errors that was reduced to only 2 errors in the post education P1 phase. The second most frequent class involved in inappropriate dosing regimen was the antiplatelet/anticoagulant medications accounting for 110 errors followed by steroids (83 errors). These errors were reduced in the P1 phase to 16 and 6 for antiplatelet/anticoagulants and steroids respectively. Regarding indications without medication, the most commonly involved classes were anti-cytokine storm medications, vitamins and antibiotics accounting for 39, 35 and 31 errors respectively which all have been reduced after education into a frequency of 1, 1 and 6 errors respectively. Antibiotics and steroids represented the most frequent medications without indication representing 119 and 38 errors respectively while antiplatelet/anticoagulant medications represented the most frequent class involved in the lack of monitoring recommendation type of errors, with a frequency of 25 errors that was reduced to 6 errors after education.

**Table 1**
Classification of prescribing errors in the two phases.

| Type | P0 phase n = 1054 | P1 phase n = 148 | p-value |
|---|---|---|---|
| Inappropriate dosing regimen, n (%) | 486 (46.1) | 44 (29.7) | 0.001 |
| Indication without medication, n (%) | 163 (15.5) | 23 (15.5) | |
| Medication with no indication, n (%) | 273 (25.9) | 48 (32.4) | |
| Lack of monitoring recommendations, n (%) | 67 (6.4) | 18 (12.2) | |
| Incomplete instructions, n (%) | 27 (2.6) | 3 (2) | |
| Wrong drugs, n (%) | 29 (2.8) | 11 (7.4) | |
| Others, n (%) | 9 (0.9) | 1 (0.7) | |

## 4. Discussion

COVID-19 disease can appear in many different ways. It can show up as mild upper respiratory infection, severe viral pneumonia, and even death (Adhikari et al., 2020). COVID-19 affects multiple organs such as the lungs, kidneys, liver, heart, and brain (Puelles et al., 2020). Thus, the drugs required to deal with a situation involve more than a single medication that treats symptoms, and may be either oxygen therapy, anticoagulation (Bikdeli et al., 2020) or antibiotics used to treat a secondary bacterial infection (Li et al., 2020). Because COVID-19 medications can have adverse drug reactions or drug–drug interactions, particularly with some drugs being assessed in clinical trials, therapies using COVID-19 should be closely monitored (Hung et al., 2020).

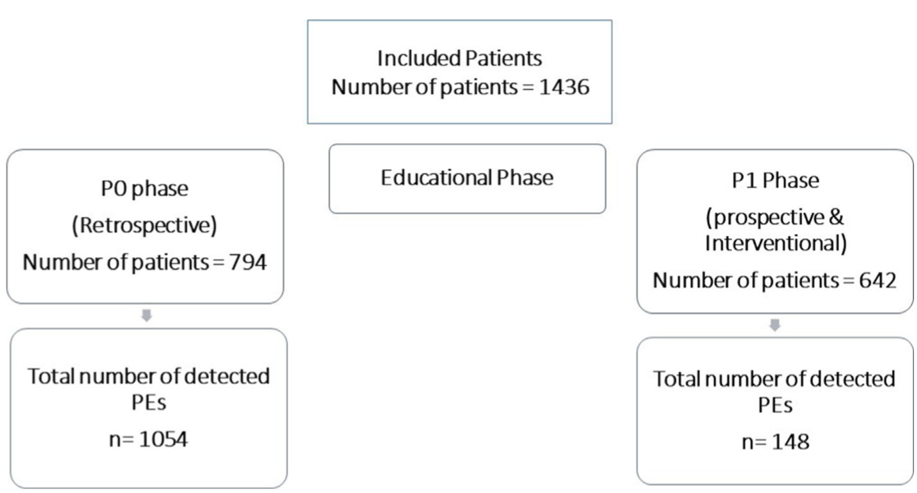


**Fig. 1.** The study flow chart.

**Table 2**
Different therapeutic classes encountered in prescribing errors in the two phases.

| Class | Type of error | P0 phase | P1 phase |
|---|---|---|---|
| **Antibiotics** | Inappropriate dosing regimen, n (%) | 55 (22) | 8 (20.5) |
| | Indication without medication, n (%) | 31 (12.4) | 6 (15.4) |
| | Medication with no indication, n (%) | 119 (47.6) | 17 (43.6) |
| | Lack of monitoring, n (%) | 26 (10.4) | 2 (5.1) |
| | Insufficient instruction, n (%) | 7 (2.8) | 1 (2.6) |
| | Wrong drugs, n (%) | 10 (4) | 4 (10.3) |
| | Others, n (%) | 2 (0.8) | 1 (2.6) |
| | **Total** | **250 (100)** | **39 (100)** |
| **Analgesics antipyretics** | Inappropriate dosing regimen, n (%) | 7 (18.4) | 5 (45.5) |
| | Indication without medication, n (%) | 1 (2.6) | 3 (27.3) |
| | Medication with no indication, n (%) | 28 (73.7) | 2 (18.2) |
| | Lack of monitoring, n (%) | 0 (0) | 1 (9.1) |
| | Wrong drugs, n (%) | 2 (5.3) | 0 (0) |
| | **Total** | **38 (100)** | **11 (100)** |
| **Antiplatelet/ anticoagulants** | Inappropriate dosing regimen, n (%) | 110 (59.1) | 16 (43.2) |
| | Indication without medication, n (%) | 20 (10.8) | 5 (13.5) |
| | Medication with no indication, n (%) | 20 (10.8) | 4 (10.8) |
| | Lack of monitoring, n (%) | 25 (13.4) | 6 (16.2) |
| | Insufficient instruction, n (%) | 3 (1.6) | 2 (5.4) |
| | Wrong drugs, n (%) | 6 (3.2) | 4 (10.8) |
| | Others, n (%) | 2 (1.1) | 0 (0) |
| | **Total** | **186 (100)** | **37 (100)** |
| **Vitamins** | Inappropriate dosing regimen, n (%) | 141 (74.2) | 2 (14.3) |
| | Indication without medication, n (%) | 35 (18.4) | 1 (7.1) |
| | Medication with no indication, n (%) | 3 (1.6) | 11 (78.6) |
| | Lack of monitoring, n (%) | 1 (0.5) | 0 (0) |
| | Insufficient instruction, n (%) | 6 (3.2) | 0 (0) |
| | Wrong drugs, n (%) | 1 (0.5) | 0 (0) |
| | Others, n (%) | 3 (1.6) | 0 (0) |
| | **Total** | **190 (100)** | **14 (100)** |
| **Steroids** | Inappropriate dosing regimen, n (%) | 83 (53.2) | 8 (33.3) |
| | Indication without medication, n (%) | 18 (11.5) | 3 (16.7) |
| | Medication with no indication, n (%) | 38 (24.4) | 7 (38.9) |
| | Lack of monitoring, n (%) | 2 (1.3) | 0 (0) |
| | Insufficient instruction, n (%) | 5 (3.2) | 0 (0) |
| | Wrong drugs, n (%) | 8 (5.2) | 2 (11.1) |
| | Others, n (%) | 2 (1.3) | 0 (0) |
| | **Total** | **156 (100)** | **18 (100)** |
| **Respiratory medications** | Inappropriate dosing regimen, n (%) | 9 (40.9) | 2 (28.6) |
| | Indication without medication, n (%) | 4 (18.2) | 3 (42.9) |
| | Medication with no indication, n (%) | 9 (40.9) | 2 (28.6) |
| | **Total** | **22 (100)** | **7 (100)** |
| **Anti-cytokine storm medications** | Inappropriate dosing regimen, n (%) | 69 (41.6) | 0 (0) |
| | Indication without medication, n (%) | 39 (23.5) | 1 (14.3) |
| | Medication with no indication, n (%) | 40 (24.1) | 3 (42.9) |
| | Lack of monitoring, n (%) | 10 (6) | 3 (42.9) |
| | Insufficient instruction, n (%) | 6 (3.6) | 0 (0) |
| | Wrong drugs, n (%) | 2 (1.2) | 0 (0) |
| | **Total** | **166 (100)** | **7 (100)** |
| **Others** | Inappropriate dosing regimen, n (%) | 12 (26.1) | 5 (33.3) |
| | Indication without medication, n (%) | 15 (32.6) | 1 (6.7) |
| | Medication with no indication, n (%) | 16 (34.8) | 2 (13.3) |
| | Lack of monitoring, n (%) | 3 (6.5) | 6 (40%) |
| | Wrong drugs, n (%) | 0 (0) | 1 (6.7) |
| | **Total** | **46 (100)** | **15 (100)** |

The participation of multidisciplinary teams is critical in the management of COVID-19 patients. While the pharmacists' role in hospital pharmacies primarily consists of dispensing of medications, clinical pharmacists can help in taking evidence-based decisions for medication, monitoring and evaluation of medication efficacy and safety, as well as managing drug interactions (Song et al., 2021). This study aimed to implement an educational program conducted by the clinical pharmacy team as an intervention to decrease the rate of PEs. In the early beginning of COVID-19 pandemic, clinical pharmacists were not highly involved in the patient care process and their only focus was on drug supply and storage. However, it was found that many drugs-related problems occurred, necessitating the involvement of clinical pharmacy team interventions. It has been reported that clinical pharmacist implemented great role during COVID-19 pandemic (Cheong, 2020).

The current study has shown that the education program significantly reduced the number of PEs from 1054 errors in the pre-education phase to only 148 errors in the post-education phase. The same was reported in pediatric emergency department where resident education program greatly reduced PEs (Foster et al., 2013). In accordance to the previously mentioned results, it has been reported that physician education reduced PEs by 33% in an educational hospital (Peeters and Pinto, 2009). Not only educational program reduced the number of errors, but it also decreased the adverse drug events in elderly patient as reported in the study of Trivalle and his colleagues reflecting the important role of education on patient's outcome (Trivalle et al., 2010). On the contrary, a study conducted in Nigeria reported that prescriber education did not reduce the overall rate of PEs, but it significantly reduced the one subtype which is incomplete instruction (Ajemigbitse et al., 2016).

The most common class encountered in PEs was antibiotics including azithromycin, cefepime and ceftriaxone. Secondary bacterial infection is a concern in COVID-19 patients leading to the use of empiric antibiotics. However, it was found to be associated with negative outcomes in increased drug resistance (Liu et al., 2021). In the current study, educational program helped to decrease the irrational prescribing of antibiotic and decreased the error related to the wrong dosing regimen. A previous study has reported that erroneous prescription of fluroquinolones was decreased by 74% following physician education (Lacombe et al., 2005), proving that education is a successful intervention to control the inappropriate use of antibiotic and decrease the incidence of microbial resistance.

The most common encountered error was the inappropriate dosing regimen including vitamins, steroids and antiplatelet/anticoagulant drugs. In a previous cross-sectional study in Netherlands, it was reported that anticoagulants represented 8.3% of the errors, most of them occurred during the prescribing phase (Dreijer et al., 2019). Improper use of anticoagulants can adversely affect patients causing either bleeding or thromboembolic events (Desai et al., 2013). Moreover, the use of steroids is associated with increased adverse effects which is dependent on dose and duration and excessive exposure can cause unnecessary harm to patients (Stanbury and Graham, 1998). The current study has shown that clinical pharmacists' education helped to control all these errors and consequently prevented patients' harm. Despite it was not evaluated in the current study, decreasing PEs can effectively reduce the healthcare cost. It has been reported that prevention of medication errors by clinical pharmacist led to cost savings of more than 340,000 dollars in a nephrology unit (Chen et al., 2017). All the previously mentioned evidence supports the great role of clinical pharmacists during COVID pandemic. The present study had a limitation as the medication review in phase P0 was retrospective. This meant that at the time, evaluation was based solely on what could be read.

## 5. Conclusion

It is concluded from the current study that changing clinical practice might lead higher rate of medication errors and hence continuing education to prescribers is recommended to reduce medication errors and their negative consequences. The clinical pharmacists have a great role in rationalizing drug prescribing during COVID-19 pandemic.

## Ethical statement

The study protocol was revised and approved by the institution research ethics committee. In addition, the approval of the hospital managerial board was obtained.

## Funding

The study was not funded by any funding bodies.

## Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

## Acknowledgement

The study was not funded by any funding bodies.

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