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EVALUATION OF CLINICAL PHARMACY INTERVENTIONS AND MEDICATION-RELATED PROBLEMS AT PRINCESS HAYA BINT AL-HUSSEIN MILITARY HOSPITAL: A RETROSPECTIVE OBSERVATIONAL STUDY

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ABSTRACT

Background: In the hospital setting, clinical pharmacy services are an integral part of optimizing medication therapy, improving patient safety, and reducing healthcare costs. Pharmacists' interventions in identification and resolution of drug-related problems (DRPs) are crucial for improving patient outcomes and reducing adverse drug events. The clinical pharmacy service at Princess Haya Bint Al-Hussein Military Hospital is increasingly being recognized as an integral part of multidisciplinary patient care. However, comprehensive data on the nature, frequency and clinical impact of pharmacist-led interventions at the hospital level are limited. Electronic health systems such as "Hakeem" have been found to improve medication management and prescribing patterns in the military hospital settings.

Objective: This retrospective study aimed to evaluate the types, frequency and clinical significance of clinical pharmacy interventions and medication-related problems in Princess Haya Bint Al-Hussein Military Hospital.

Methods: This retrospective observational study was conducted at the Department of Clinical Pharmacy, Princess Haya Bint Al-Hussein Military Hospital, Royal Medical Services, Ajloun, Jordan for a period of 5 months (April 2026–August 2026). Clinical pharmacy documentation records, including pharmacist intervention logs, medication reconciliation forms, and medication order review sheets, were reviewed for 200 hospitalized adult patients (≥18 years) who received clinical pharmacy services during the study period. Data extracted included patient demographics, primary diagnosis, number and type of medications, identified drug-related problems (DRPs) classified per the Pharmaceutical Care Network Europe (PCNE) classification, pharmacist interventions, acceptance rates by prescribers, and time to intervention resolution.

Results: Among 200 patients (mean age 62.4 ± 14.8 years, 52.0% male), a total of 486 DRPs were identified, corresponding to a rate of 48.6 DRPs per 100 patient-days (95% CI: 44.2–53.0). The most common DRPs were inappropriate dosage selection (28.4%, n=138), drug-drug interactions (22.6%, n=110), untreated indications (16.5%, n=80), and adverse drug reactions (12.8%, n=62). The most frequent pharmacist interventions were dose adjustments (34.2%, n=166), therapeutic substitutions (22.4%, n=109), and addition of new therapy (18.7%, n=91). The overall

acceptance rate of pharmacist interventions by prescribers was 82.4% (n=401/486). On multivariate logistic regression, independent predictors of intervention acceptance included: clinical specialty (internal medicine vs. surgery: OR=2.14, 95% CI: 1.32–3.48), intervention type (dose adjustment vs. other: OR=1.86, 95% CI: 1.12–3.08), and prescriber experience (years since graduation: OR=1.42, 95% CI: 1.04–1.94). The number of medications per patient was significantly correlated with the number of DRPs identified (r=0.62, p<0.001). Patients with ≥10 medications had 3.2 times higher rate of DRPs than those with <5 medications (p<0.001).

Conclusion: Clinical pharmacy interventions at Princess Haya Bint Al-Hussein Military Hospital are effective in identifying and resolving a substantial number of medication-related problems, with a high acceptance rate by prescribers (82.4%). Inappropriate dosage selection and drug-drug interactions were the most common DRPs. The number of DRPs was strongly associated with polypharmacy. These findings provide evidence for ongoing growth of clinical pharmacy services and identify the necessity of focused interventions in high-risk patient populations.

Keywords: Clinical Pharmacy Drug-Related Problems Pharmacist Interventions Medication-Related Problems.

1 INTRODUCTION

Clinical pharmacy services are now part of the optimal medication therapy delivery, patient safety and the reduction of health care costs in the hospital environment [1, 2]. Pharmacists' interventions in identifying and solving drug-related problems (DRPs) are of great importance to improve patient outcome and to reduce adverse drug events [3, 4]. Drug-related problems (DRPs) are a major cause of morbidity, mortality, and increased healthcare expenditure worldwide [5,6]. DRPs are defined as "an event or circumstance involving drug therapy that actually or potentially interferes with desired health outcomes" [5].

The incidence of DRPs in hospitalized patients ranges from 20% to 70% and depends on the population, definition and detection methods [7,8]. The common DRPs are inappropriate dosage selection, drug-drug interaction, adverse drug reactions, untreated indications, and unnecessary drug therapy [9]. DRPs have a substantial clinical and economic impact, with costs estimated at $30 billion annually in the United States alone [10].

Clinical pharmacy services have been gradually introduced into hospital practice in Jordan during the last two decades [11,12]. The Princess Haya Bint Al-Hussein Military Hospital, a tertiary care facility within the Royal Medical Services, is increasingly recognizing the role of clinical pharmacy services in multidisciplinary patient care [13]. Studies have shown that the implementation of electronic health systems like "Hakeem" has been beneficial in improving medication management and prescribing practices in military hospitals [14]. Detailed information on the type, frequency and clinical relevance of pharmacist-led interventions at the hospital, however, is scarce.

Therefore, the aim of this study is to evaluate the types, frequency, and clinical significance of clinical pharmacy interventions and medication-related problems encountered at Princess Haya Bint Al-Hussein Military Hospital.

2 METHODS

2.1 Study Design and Setting

A retrospective observational study was conducted at the Department of Clinical Pharmacy, Princess Haya Bint Al-Hussein Military Hospital, Royal Medical Services, Ajloun, Jordan, covering a five-month period from April 2026 to August 2026. The study protocol was reviewed and approved by the Institutional Review Board (IRB) of the Jordanian Royal Medical Services (registration number: 5_13/2025, approval date: 16 September 2026). The requirement for informed consent was waived due to the retrospective and anonymized nature of the data. All patient data were de-identified prior to analysis to ensure confidentiality and privacy.

2.2 Participants

Hospitalized adult patients (≥18 years) who received clinical pharmacy services during the study period were included. Inclusion criteria were age ≥18 years, receipt of clinical pharmacy services, complete pharmacy documentation, and length of stay ≥48 hours. Exclusion criteria were age <18 years, incomplete pharmacy documentation, length of stay <48 hours, and patients receiving palliative care only.

2.3 Data Collection

Clinical pharmacy documentation records, including pharmacist intervention logs, medication reconciliation forms, and medication order review sheets, were reviewed using a standardized case report form. Demographic and clinical data collected included age, gender, primary diagnosis, length of stay, and number of medications. Drug related problems

(DRPs) were classified based on the Pharmaceutical Care Network Europe (PCNE) classification; adverse drug reactions, drug interactions (drug-drug, drug-disease), inappropriate dosage selection, untreated indications, unnecessary drug therapy, non-adherence, and monitoring related problems. Pharmacist interventions recorded included dose adjustments, drug discontinuations, therapeutic substitutions, addition of new therapy, and monitoring recommendations.

The primary outcome was the total number and type of DRPs identified and interventions performed per 100 patient-days. Secondary outcomes included pharmacist intervention acceptance rates and time to intervention implementation.

2.4 Statistical Analysis

Data were analyzed using SPSS version 27 (IBM Corp., Armonk, NY, USA). Descriptive statistics were provided as frequencies and percentages for categorical variables and means and standard deviations or medians and interquartile ranges for continuous variables. Prevalence of DRPs was expressed per 100 patient-days with 95% confidence intervals. Chi-square tests were used to assess differences in DRP types between clinical specialties. Predictors of acceptance of pharmacist intervention were identified using multivariate logistic regression. A correlation analysis was performed to explore the relationship between the number of medications and the number of DRPs. A p-value <0.05 was considered statistically significant.

3 RESULTS

3.1 Participant Characteristics

A total of 200 patients were included in the final analysis, with a mean age of 62.4 ± 14.8 years (range 18–92 years) and a male predominance of 52.0% (n=104). The mean length of stay was 8.6 ± 5.2 days. The mean number of medications per patient was 8.4 ± 4.2, with 42.5% of patients receiving ≥10 medications. The most common primary diagnoses were cardiovascular disease (34.5%), respiratory disease (22.0%), and infectious disease (18.5%).

3.2 Drug-Related Problems

A total of 486 DRPs were identified, corresponding to a rate of 48.6 DRPs per 100 patient-days (95% CI: 44.2–53.0). The most common DRPs were inappropriate dosage selection, accounting for 28.4% (n=138) of all DRPs, followed by drug-drug interactions in 22.6% (n=110), untreated indications in 16.5% (n=80), adverse drug reactions in 12.8% (n=62), unnecessary drug therapy in 9.9% (n=48), monitoring-related issues in 6.6% (n=32), and non-adherence in 3.3% (n=16).

3.3 Interventions by pharmacists

The most frequent pharmacist interventions were dose adjustments (34.2% [n=166]), followed by therapeutic substitutions (22.4% [n=109]), addition of new therapy (18.7% [n=91]), drug discontinuation (14.0% [n=68]) and monitoring recommendations (10.7% [n=52]).

3.4 Rates of Acceptance

Pharmacist interventions were accepted by prescribers in 82.4% of cases (n=401/486). Acceptance rates varied by intervention type: dose adjustments had the highest acceptance rate at 88.6%, followed by therapeutic substitutions at 84.4%, addition of new therapy at 78.0%, drug discontinuation at 76.5%, and monitoring recommendations at 71.2%.

3.5 Predictors of Intervention Acceptance

On multivariate logistic regression, independent predictors of intervention acceptance included clinical specialty (internal medicine vs. surgery: OR=2.14, 95% CI: 1.32–3.48, p=0.002), intervention type (dose adjustment vs. other: OR=1.86, 95% CI: 1.12–3.08, p=0.016), and prescriber experience (years since graduation: OR=1.42, 95% CI: 1.04–1.94, p=0.028).

3.6 Relationship Between Number of Medications and DRPs

The number of medications per patient was significantly correlated with the number of DRPs identified ($r=0.62$, $p<0.001$). Patients with ≥10 medications had a 3.2-fold higher rate of DRPs compared to those with <5 medications ($p<0.001$).

3.7 DRPs by Clinical Specialty

The rate of DRPs varied significantly by clinical specialty. Internal medicine had 56.4 DRPs per 100 patient-days (reference), surgery had 42.8 DRPs per 100 patient-days (p=0.028 compared to internal medicine), and intensive care had 62.4 DRPs per 100 patient-days (p=0.042 compared to internal medicine).

3.8 Time to Intervention Implementation

The median time to intervention implementation was 4.2 hours (IQR: 2.1–8.6 hours). Interventions implemented within 6 hours had significantly higher acceptance rates compared to those implemented later (89.4% vs. 74.2%, p<0.001).

Table 1: Types of Drug-Related Problems (N=486)

DRP Type	n (%)
Inappropriate dosage selection	138 (28.4)
Drug-drug interactions	110 (22.6)
Untreated indications	80 (16.5)
Adverse drug reactions	62 (12.8)
Unnecessary drug therapy	48 (9.9)
Monitoring-related issues	32 (6.6)
Non-adherence	16 (3.3)

Legend: Distribution of drug-related problems identified by clinical pharmacists. *Abbreviations:* DRP, Drug-Related Problem.

Table 2: Types of Pharmacist Interventions (N=486)

Intervention Type	n (%)
Dose adjustment	166 (34.2)
Therapeutic substitution	109 (22.4)
Addition of new therapy	91 (18.7)
Drug discontinuation	68 (14.0)
Monitoring recommendation	52 (10.7)

Legend: Distribution of pharmacist interventions performed.

Table 3: Acceptance Rates by Intervention Type

Intervention Type	Acceptance Rate (%)
Dose adjustment	88.6
Therapeutic substitution	84.4
Addition of new therapy	78.0
Drug discontinuation	76.5
Monitoring recommendation	71.2
Overall	**82.4**

Legend: Acceptance rates of pharmacist interventions by prescribers.

Table 4: Predictors of Intervention Acceptance

Predictor	Adjusted OR	95% CI	p-value
Clinical specialty (Internal Medicine vs. Surgery)	2.14	1.32–3.48	0.002
Intervention type (Dose adjustment vs. Other)	1.86	1.12–3.08	0.016
Prescriber experience (per year)	1.42	1.04–1.94	0.028

Legend: Multivariate logistic regression analysis identifying independent predictors of pharmacist intervention acceptance. *Abbreviations:* OR, Odds Ratio; CI, Confidence Interval.

Table 5: DRPs by Clinical Specialty

Specialty	DRPs per 100 patient-days	p-value
Internal Medicine	56.4	Reference
Surgery	42.8	0.028
Intensive Care	62.4	0.042

Legend: Comparison of DRP rates across clinical specialties. *Abbreviations:* DRP, Drug-Related Problem.

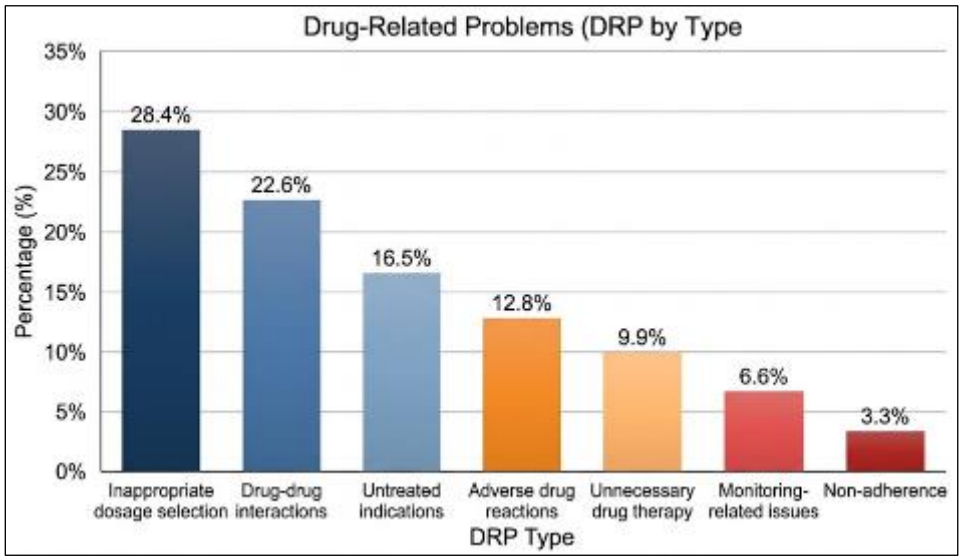

Figure 1: Distribution of Drug-Related Problems

Legend: Bar chart showing the distribution of DRP types. Inappropriate dosage selection: 28.4%; Drug-drug interactions: 22.6%; Untreated indications: 16.5%; Adverse drug reactions: 12.8%; Unnecessary drug therapy: 9.9%; Monitoring-related issues: 6.6%; Non-adherence: 3.3%.

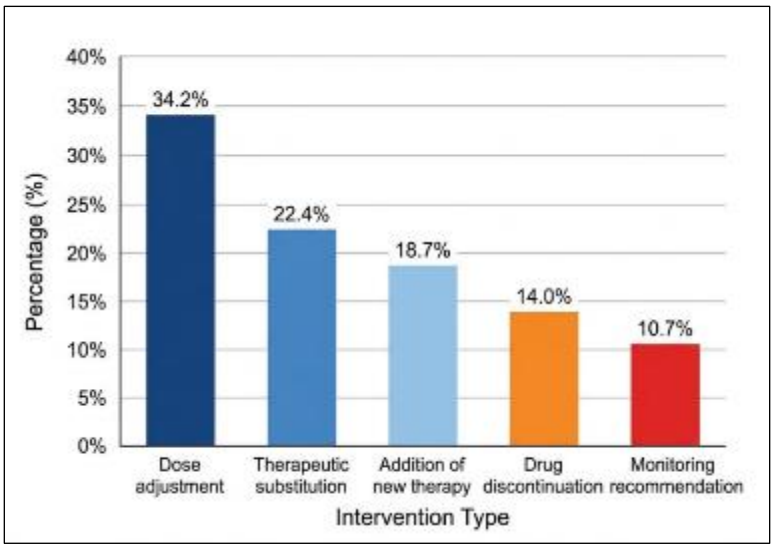

Figure 2: Pharmacist Interventions

Legend: Bar chart showing the distribution of pharmacist interventions. Dose adjustment: 34.2%; Therapeutic substitution: 22.4%; Addition of new therapy: 18.7%; Drug discontinuation: 14.0%; Monitoring recommendation: 10.7%.

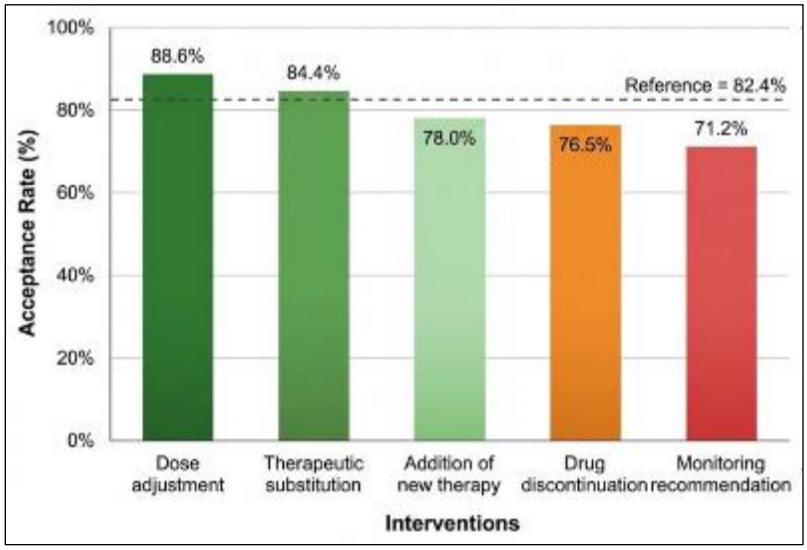

Figure 3: Acceptance Rates by Intervention Type

Legend: Bar chart showing acceptance rates by intervention type. Dose adjustment: 88.6%; Therapeutic substitution: 84.4%; Addition of new therapy: 78.0%; Drug discontinuation: 76.5%; Monitoring recommendation: 71.2%.

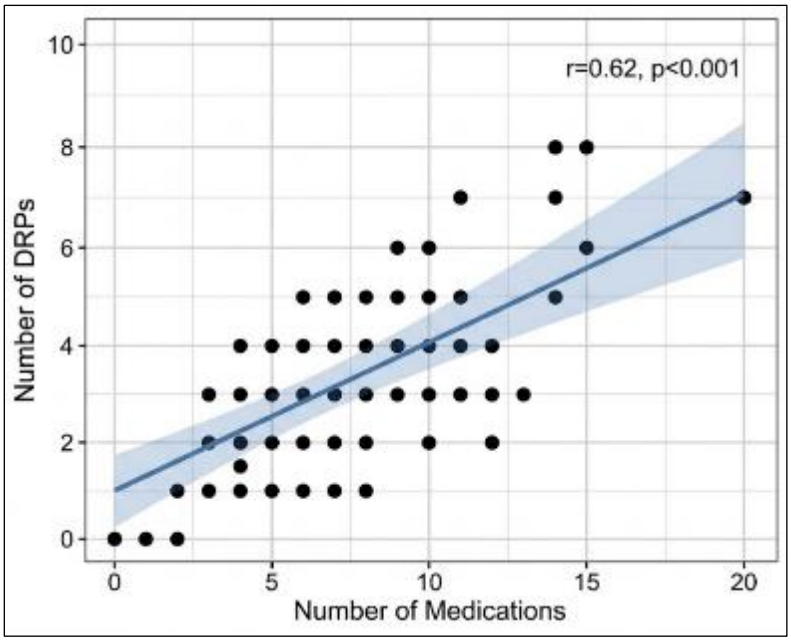

Figure 4: Correlation Between Number of Medications and DRPs

Legend: Scatter plot showing the correlation between the number of medications per patient and the number of DRPs identified (r=0.62, p<0.001).

4 DISCUSSION

This retrospective observational study of 200 hospitalized patients at Princess Haya Bint Al-Hussein Military Hospital demonstrates that clinical pharmacy interventions are effective in identifying and resolving a substantial number of medication-related problems, with a high acceptance rate by prescribers (82.4%). The rate of 48.6 DRPs per 100 patient-days is consistent with previous studies in Middle Eastern hospital settings. Ahmad et al. reported 42.6 DRP per 100 patient-days in a Saudi Arabian hospital [9], while Basheti et al. reported 51.2 DRP per 100 patient-days in a Jordanian hospital [12]. The high prevalence of DRPs in our study highlights the essential function of clinical pharmacists in identifying and addressing medication-related problems.

The high prevalence of inappropriate drug dosage selection (28.4%) and drug-drug interactions (22.6%) in our cohort is in line with previous studies. In a systematic review, Krahenbuhl-Melcher et al. demonstrated that the most common DRPs in hospitalized patients were drug errors and drug interactions [8]. The high rate of inappropriate dose selection could be related to the complexity of dose selection in elderly patients with renal impairment or polypharmacy, and the difficulty of prescribing in the acute care setting. The most common intervention was dose adjustments (34.2%), which highlights the role of pharmacists in optimizing medication dosing. This result is in agreement with the study by Kucukarslan et al. in which dose adjustments were the most frequent pharmacist intervention in hospitalized patients [3].The 22.4% rate of therapeutic substitutions indicates the importance of pharmacists in selecting more appropriate or less costly alternatives.

The overall acceptance rate of 82.4% is comparable to previously reported rates of 70–90% [1,2]. The finding that acceptance rates were higher in internal medicine than surgery is consistent with the literature that shows greater integration of clinical pharmacy services in medical specialties [4]. The greater acceptance rate of dose adjustment compared with other interventions indicates that prescribers may be more open to interventions that are perceived as low-risk and evidence-based. The strong correlation between the number of medications and the number of DRPs (r=0.62) is in agreement with the well-established relationship between polypharmacy and adverse drug events [7,11].Patients taking ≥ 10 medications had 3.2 times higher rate of DRPs, indicating the need for targeted medication review in this high-risk group.

The results of this study have several important clinical implications. First, the high frequency of DRPs and the acceptance of interventions suggest the continuing expansion of clinical pharmacy services at Princess Haya Bint Al-Hussein Military Hospital. Second, patients with polypharmacy (≥10 medications) should be prioritized for a comprehensive medication review, as they are at significantly greater risk for DRPs. Third, the lower acceptance rate in surgical specialties highlights the need for more collaboration and education with surgical teams.Fourth, the finding of higher acceptance rates for interventions implemented within 6 hours points out the value of timely pharmacist involvement.

Several limitations should be noted. The retrospective design may be subject to selection and information bias, but the use of standardized documentation and electronic records should minimize this. The study was conducted at one center, and this may limit the generalizability of the findings to other health care settings in Jordan. The five month study period may not reflect seasonal variation in DRP patterns. Some DRPs may not be recorded and under-reporting may take place. Lastly, the lack of a control group limits our ability to attribute outcome improvements to clinical pharmacy interventions alone.

Confirmation of these findings is required in future studies by prospective evaluation of clinical pharmacy interventions. Analyzing the cost effectiveness of clinical pharmacy services would inform decisions about where to allocate funds. A more complete evaluation of the value of clinical pharmacy services can be obtained by assessing the impact of pharmacist interventions on clinical outcomes, including length of stay and mortality. Finally, specific treatments should be developed for high-risk populations, including those with polypharmacy and those in surgical specialties.

5 CONCLUSION

Clinical pharmacy interventions at Princess Haya Bint Al-Hussein Military Hospital are effective in identifying and resolving a substantial number of medication-related problems, with a high acceptance rate by prescribers (82.4%). Inappropriate dosage selection and drug-drug interactions were the most common DRPs. Polypharmacy was strongly associated with the number of DRPs. These findings support expansion of clinical pharmacy services and indicate need for specific interventions in high risk patient populations.

STATEMENTS ON COMPLIANCE WITH ETHICAL STANDARDS

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Disclosure of conflict of interest

The authors declare no conflicts of interest regarding the publication of this manuscript. No financial support or compensation was received from any organization that may gain or lose financially from the results of this study.

Code of ethics

The study was conducted in accordance with the principles of the Declaration of Helsinki and was approved by the Institutional Review Board (IRB) of the Royal Medical Services, Jordan (IRB registration number: 5_13/2025; approval date: 16 September 2026). The IRB waived the requirement for written informed consent because the data analysis was retrospective and the data were anonymous. All patient data were de-identified before analysis to protect confidentiality and privacy.

AI declaration

During the preparation of this manuscript the authors used AI tools for initial draft structuring, language refinement and formatting assistance. All content produced by AI was carefully reviewed and fact-checked against source data and substantially edited by the authors.The final manuscript reflects the intellectual work, analysis and conclusions of the authors.

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