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Original Research Article

Reducing pediatric prescription errors: a quality improvement initiative in a tertiary-care outpatient setting

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ABSTRACT

Background: Prescription errors are among the most common preventable causes of harm in healthcare, especially in pediatrics. This study was conducted to identify, analyze and reduce prescription errors using Quality improvement methods like Plan-Do-Study-Act (PDSA) cycles. Our study question was "Does implementing PDSA-based quality improvement interventions reduce prescription errors in the pediatric outpatient department of a tertiary care hospital in Western India?

Methods: This study was conducted in the pediatric out-patient department (OPD) of a GMERS Medical College and Sola hospital in Western India from February 2025 to April 2025. The intervention was implemented in two PDSA cycles. PDSA-1 involved the introduction of a revised pediatric formulary and daily pre-OPD educational briefings. PDSA-2 introduced standard treatment protocols (STP) reinforced through interactive sessions. Prescription errors were classified into predefined categories and analyzed across three phases: baseline, PDSA-1, and PDSA-2. Data were analyzed using descriptive statistics, chi-square tests, and ANOVA test with significance set at $p<0.05$.

Results: A total of 1,188 prescriptions were reviewed (baseline: 591; PDSA-1: 353; PDSA-2: 244). The overall error rate declined from 27.2% at baseline to 20.1% during PDSA-1 and 9.0% during PDSA-2 ($p<0.001$). Significant reductions were observed in wrong dose errors (5.58% to 1.64%), dose omissions (1.69% to 0.41%), and missing duration (2.54% to 1.23%). Wrong drug errors showed minimal change, indicating the need for more advanced interventions.

Conclusions: Low-cost QI interventions can significantly enhance prescribing safety in resource-limited settings, although more complex errors may require digital or system-level solutions.

Keywords: Rational drug use, Clinical audit, Drug dosing, Medication safety, Standard treatment protocol

INTRODUCTION

A prescription is a directive for medication issued by a licensed medical practitioner to a pharmacist, serving simultaneously as a clinical, legal, and financial document. As such, it must be precise, legible, legally compliant, and free from nonstandard abbreviations to ensure successful pharmacotherapy and optimal patient outcomes.[1,2]

Prescription errors are a significant, yet largely preventable, contributor to adverse drug events, particularly in pediatric populations. The need for weight- or body surface area-based dosing introduces additional complexity, increasing the risk of errors such as incorrect doses, illegibility, and omission of critical details like

patient weight or dosing frequency.[3,4] Indeed, prescribing errors commonly account for the majority of medication mishaps in pediatric settings.[5]

To combat this, quality improvement (QI) methodologies, especially the Plan-Do-Study-Act (PDSA) cycle, have been employed with notable success. A recent Indian outpatient QI initiative using two PDSA cycles saw prescribing errors decrease from 72.2% to 22.5%.[6] Similarly, a Kolkata NICU-based POCQI program incorporating four cycles, digital prescribing, and countersignatures achieved a reduction in medication errors from 63% to 10.4%.[7] On the other hand, a US-based academic pediatric emergency department applied multidisciplinary, technology-enhanced strategies and halved prescription errors from 8.6 to 4.5 per 1,000 prescriptions.[8]

Systematic reviews affirm that multifaceted interventions, bundles combining administrative standardization, education, and engineering controls like computerized order entry and decision support, demonstrate superior performance in error reduction compared to isolated measures.[9] Notably, CPOE implementation has been associated with an 80% reduction in prescribing errors and a 55% decrease in harmful errors.[10]

India's persistent burden of incomplete and erroneous prescriptions, where nearly half may deviate from treatment guidelines, highlights an urgent need for scalable, effective QI strategies.[11] Even in high-resource environments, pediatric intensive care medication error rates range from 14% to 49% of orders, demonstrating that prescription safety remains a global challenge.[12]

This study evaluated the impact of two successive PDSA cycles, incorporating standardized prescribing order templates, targeted training, and regular audit-feedback loops, on reducing prescription errors in a pediatric outpatient setting.

METHODS

Study setting

This study was conducted in the Pediatric Outpatient Department (OPD) of GMERS Medical College and Sola hospital in Western India. The OPD caters to approximately 150 pediatric patients daily. The department is staffed on a rotational basis every three months, comprising of one pediatric faculty member, one senior resident (SR), two junior residents, and one medical intern. All clinical documentation, including patient complaints, examination findings, investigations, and treatment advice, was hand-written by the prescribing physician on standardized prescription sheets issued at the hospital registration desk.

Data collection

Based on a survey and focused group discussion (FGD) involving all pediatric faculties, the common prescription errors identified during outpatient prescriptions writing, interventions, and outcome parameters were drafted (Table 1). Apart from this, additional errors were also included, such as errors related to supportive management, formulation/dosage and the use of inappropriate abbreviations. Prescriptions written exclusively by junior residents were included in the study. Those issued by faculty members were excluded, as they were involved in the evaluation of prescription errors. Prescriptions by senior residents were also excluded, as they participated in prescription collection, which could introduce observer bias. Additionally, prescriptions written by interns and nursing staff were excluded, as they are not authorized to prescribe medications independently and are expected to function strictly under the supervision of a qualified pediatrician. Ethical approval for the study was taken from the institutional ethics committee. Written consent was taken from patients before data collection.

At baseline, the prescriptions collected from February 13, 2025 to March 1, 2025 (15 days). This was followed by the focused intervention meeting involving all junior residents and the preliminary analysis of prescription errors from the preceding week was discussed. After sensitization of the attendees of the meeting to this problem, the most probable reasons for errors were identified using 5 why root cause analysis method and measures to reduce the prescription error were formulated, leading to the initiation of the intervention project (Figure 1).

Table 1: The operational definitions according to the types of prescription errors.

S. no.	Errors	Operational definition
1.	Wrong dose	Prescribing correct medicine for the diagnosis in a dose that is more or less than the recommended dose as per the body weight of the patient
2.	Wrong duration	Prescribing correct medicines for the diagnosis that is less than or more than the recommended duration of treatment
3.	Wrong drug	Prescribing medicine which was not required by the patient, or which is not evidence-based or currently useful for the current diagnosis

Continued.

S. no.	Errors	Operational definition
4.	Missed drug	Prescription which did not contain one or more drugs recommended for treatment or prophylaxis of the patient's condition
5.	Dose not mentioned	Prescribing medicine without mentioning the appropriate dose.
6.	Generic name	Prescribing medicine without mentioning the Generic name.

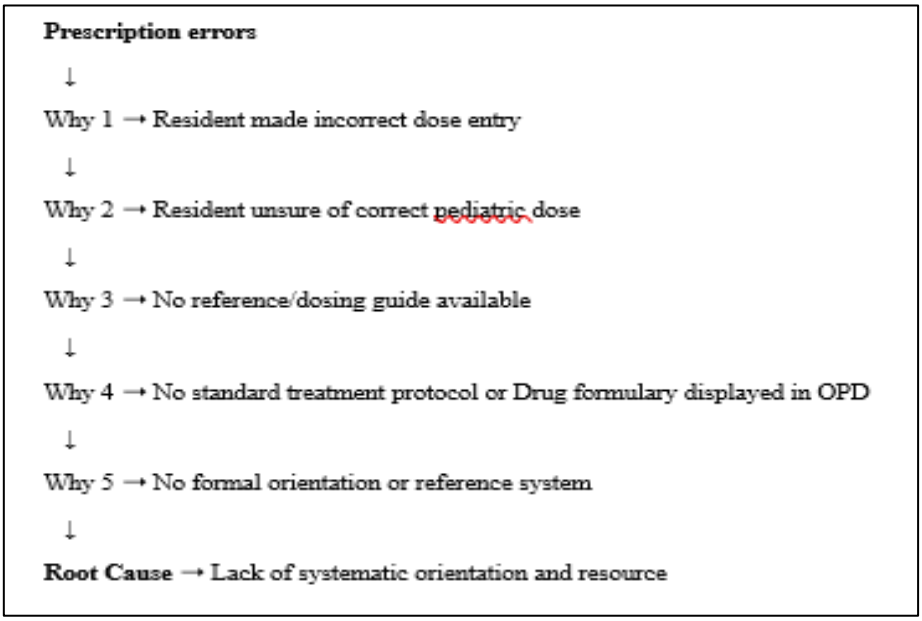

Figure 1: Pediatric prescription errors: 5 why root cause analysis.

Intervention

The QI project was conducted using a PDSA cycle approach to systematically identify, address, and reduce prescription errors in a clinical setting. The study was implemented over three phases: baseline, PDSA cycle 1, and PDSA cycle 2, with each phase building upon the learnings of the previous one (Figure 2).

The first PDSA-1 cycle was run from March 3, 2025 to March 19, 2025 (15 days) with formation of a QI team consisting of three pediatric faculties. During the baseline assessment, it was observed that the existing drug dose chart in the OPD was outdated. Consequently, the QI team initiated the development of a revised drug formulary tailored to the drugs commonly prescribed and readily available in the pediatric OPD (Appendix 1). The formulary included appropriate dosages and indications, based on standard pediatric guidelines, and was iteratively refined through team discussions. Feedback was collected throughout the PDSA-1 phase to ensure the adherence to protocol. To enhance accessibility, printed copies of drug formulary were placed on every consultation table in the OPD. Additionally, a 10-15-minute daily briefing session was conducted by a pediatric faculty member before the commencement of OPD hours. These sessions were designed to familiarize junior residents with the contents and use of the revised formulary.

The PDSA-2 cycle was run from April 4, 2025 to April 21, 2025 (15 days). In the PDSA-2 cycle, a STP was developed and implemented. This STP was based on established clinical guidelines and tailored to local clinical practices and institutional infrastructure through consensus within the QI team. During the first week of PDSA-2, a dedicated briefing session was held to introduce the STP to junior residents. To ensure understanding and sustainability of this intervention, the second week of the cycle involved daily interactive sessions led by pediatric faculty members. These sessions involved brief 15-minute meetings held before OPD hours, during which faculty conducted clinical questioning of junior residents to reinforce key concepts, promote adherence to standardized protocols, and ensure the sustainability of the intervention.

Data analysis

Data was entered in excel sheet and shared amongst the QI team members at each team meeting. Prescription error was calculated and expressed as a percentage. Statistical significance was analyzed using appropriate statistical tools.

Quantitative data were analyzed using descriptive statistics. Error rates were calculated as the proportion of errors per total prescriptions in each phase. A comparative data was analysed by simple Chi-square test with p value less than 0.05 taken as statistically significant. Analysis of variance (ANOVA) was used to detect the significance of the difference in mean between errors obtained at baseline, before, and after the PDSA cycles.

RESULTS

A total of 591 prescriptions were reviewed during the baseline phase, 353 during PDSA-1, and 244 during PDSA-2. Across the three phases, there was a progressive and marked reduction in prescription errors. Total errors decreased from 161 (27.2%) at baseline to 71 (20.1%) during PDSA-1 and further to 22 (9%) during PDSA-2 (Figure 3).

Table 2: P values for pairwise comparisons of error proportions across phases.

Comparison	P value (significance)
Baseline vs PDSA-1	0.0019 (significant)
PDSA-1 vs PDSA-2	0.0027 (significant)
Baseline vs PDSA-2	<0.00001 (highly significant)

Table 3: Category-wise prescription error rates with 95% confidence intervals.

Error type	Baseline (n=591)	PDSA-1 (n=353)	PDSA-2 (n=244)
Wrong drug	1.02% (0.47–2.20%)	2.55% (1.35–4.77%)	2.05% (0.88–4.71%)
Generic name used	12.35% (9.94–15.25%)	5.95% (3.92–8.92%)	3.69% (1.95–6.86%)
Wrong dose	5.58% (4.00–7.74%)	4.82% (3.03–7.58%)	1.64% (0.64–4.14%)
Missed drug	1.69% (0.92–3.09%)	3.68% (2.16–6.20%)	0.00% (0.00–1.55%)
Wrong duration	2.54% (1.54–4.15%)	0.00% (-0.00–1.08%)	1.23% (0.42–3.55%)
Dose not mentioned	1.69% (0.92–3.09%)	0.85% (0.29–2.47%)	0.41% (0.07–2.28%)
Other errors	2.37% (1.42–3.94%)	2.27% (1.15–4.41%)	0.00% (0.00–1.55%)

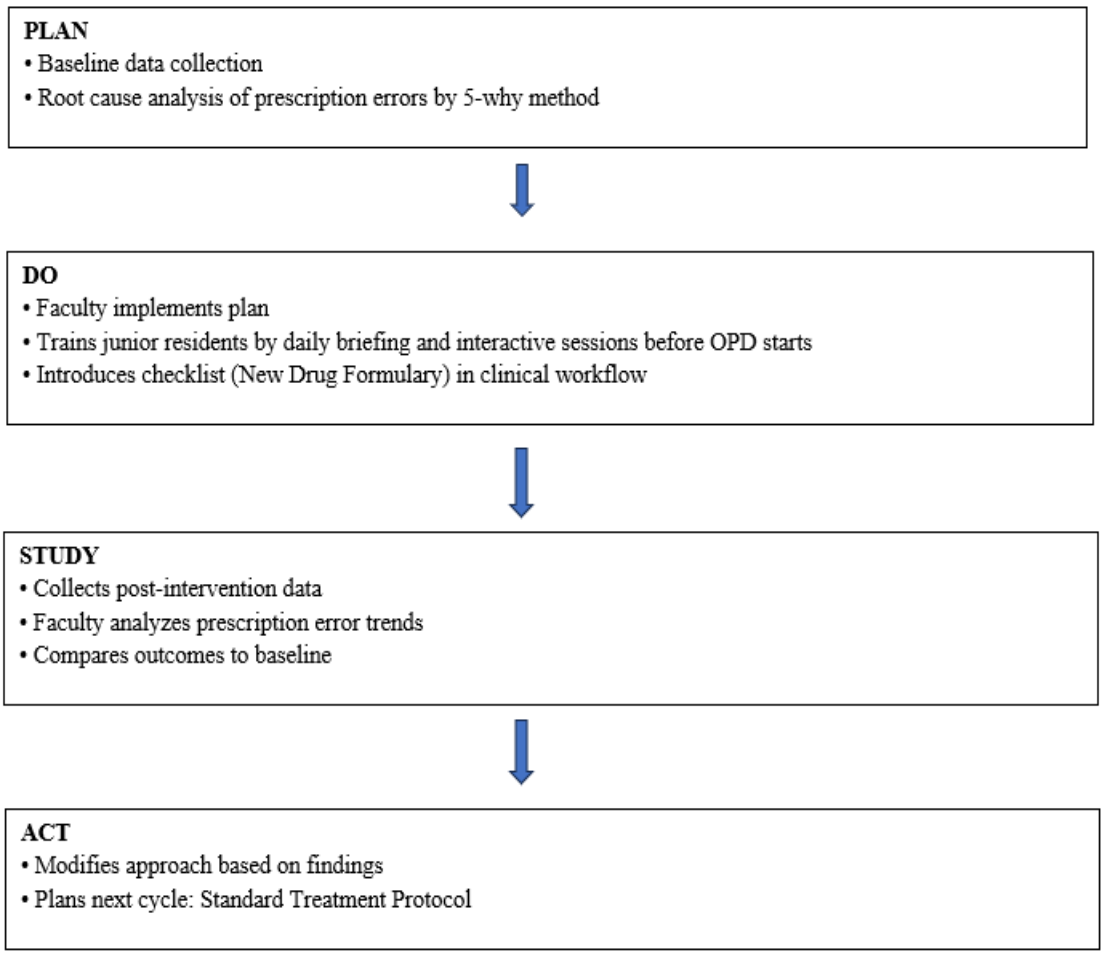

Figure 2: Pediatric faculty-led PDSA cycle to reduce pediatric prescription errors.

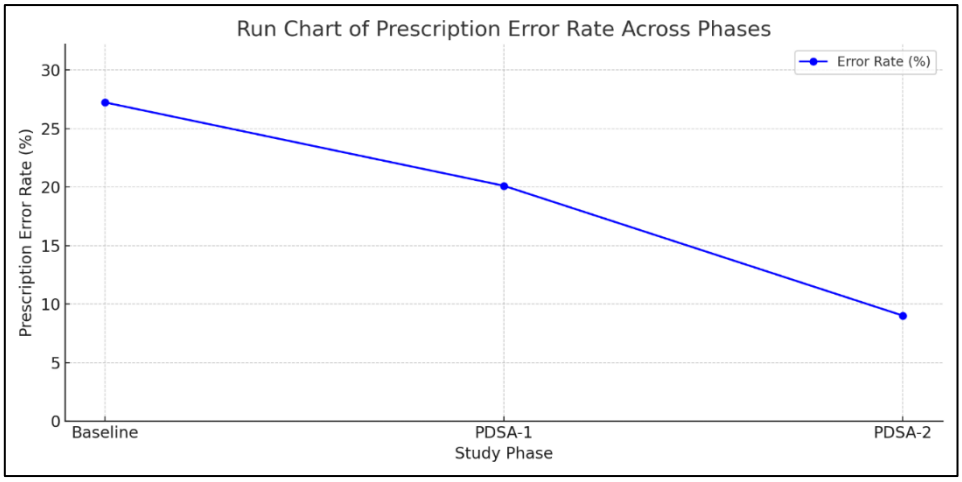

Figure 3: Run chart showing the trend of overall prescription error rate (%) across baseline, PDSA cycle 1, and PDSA cycle 2.

A one-way ANOVA was performed to compare the proportion of prescriptions with errors across the three phases. The analysis revealed a statistically significant difference in error rates among the phases ($F(2, 1185) = 17.78$, $p<0.001$), indicating that the interventions implemented during the PDSA cycles were associated with a meaningful reduction in prescription errors.

The reduction in error proportions between baseline and PDSA-1 ($p=0.0019$) and between PDSA-1 and PDSA-2 ($p=0.0027$) were both statistically significant. The direct comparison between baseline and PDSA-2 demonstrated a highly significant improvement ($p<0.00001$) (Table 2). Overall, the PDSA cycles demonstrated a substantial reduction in prescribing errors, both in frequency and severity, highlighting the effectiveness of the implemented quality improvement measures.

The proportion of prescriptions with at least one error declined from 24.2% (143/591) at baseline to 16.4% (58/353) during PDSA-1, and to 8.6% (21/244) during PDSA-2. Prescriptions with multiple errors also decreased, with three cases of three or more errors identified at baseline, reducing to one case during PDSA-1 and none during PDSA-2. The 95% confidence intervals for the proportion of prescriptions with at least one error also narrowed over time, suggesting increasing consistency in prescribing quality.

Analysis of error types revealed substantial improvements across several categories. At baseline, 73 out of 591 prescriptions (12.35%; 95% CI: 10.06-15.06%) included drugs prescribed by their generic names. This proportion declined significantly to 21 out of 353 (5.95%; 95% CI: 3.95-8.86%) during PDSA cycle 1, and further to 9 out of 244 prescriptions (3.69%; 95% CI: 1.96-6.88%) in PDSA cycle 2. During the baseline phase, 6 out of 591 prescriptions (1.02%; 95% CI: 0.42-2.24%) contained wrong drug errors. This proportion increased to 9 out of 353 (2.55%; 95% CI: 1.35-4.80%) during PDSA cycle 1 and slightly decreased to 5 out of 244 (2.05%; 95% CI: 0.88-4.66%) during PDSA cycle 2. While there was a numerical increase in the rate of wrong drug errors from baseline to PDSA cycles, statistical analysis revealed that the differences were not statistically significant due to small sample sizes and overlapping confidence intervals. These findings suggest the need for continued monitoring and reinforcement of correct drug selection practices. Wrong dose errors were noted in 33 out of 591 prescriptions (5.58%; 95% CI: 4.00-7.71%) during the baseline phase. This declined to 17 out of 353 prescriptions (4.82%; 95% CI: 3.02-7.60%) during PDSA cycle 1, and further reduced to 4 out of 244 prescriptions (1.64%; 95% CI: 0.63-4.16%) during PDSA cycle 2. Wrong duration errors were observed in 15 out of 591 prescriptions (2.54%; 95% CI: 1.55-4.13%) during the baseline phase. These errors were completely eliminated during PDSA cycle 1 (0 out of 353; 0.00%; 95% CI: 0.00-1.06%), indicating a significant improvement. However, a minor recurrence was noted during PDSA cycle 2 with 3 out of 244 prescriptions (1.23%; 95% CI: 0.42-3.56%). Despite this, the overall reduction from baseline remained significant, suggesting sustained benefit from the interventions, although ongoing reinforcement may be required to prevent relapse. Errors where the drug dose was not mentioned occurred in 10 out of 591 prescriptions (1.69%; 95% CI: 0.92-3.18%) during the baseline phase. This reduced to 3 out of 353 prescriptions (0.85%; 95% CI: 0.29-2.46%) in PDSA cycle 1, and further to just 1 out of 244 prescriptions (0.41%; 95% CI: 0.07-2.28%) in PDSA cycle 2. Although statistical significance could not be established due to small sample sizes, the consistent decline across the three phases highlights a clinically meaningful improvement. Missed drug errors were recorded in 10 out of 591 prescriptions (1.69%; 95% CI: 0.92-3.18%) at baseline and increased slightly to 13 out of 353

prescriptions (3.68%; 95% CI: 2.16-6.21%) during PDSA cycle 1. However, a marked improvement was observed during PDSA cycle 2, where no missed drug errors were noted (0 out of 244; 0.00%; 95% CI: 0.00-1.55%). Additionally, other errors such as errors related to supportive management, formulation/dosage and the use of inappropriate abbreviations were completely eradicated by PDSA-2 (Table 3).

DISCUSSION

This study demonstrated a significant and sustained reduction in pediatric prescription errors through the implementation of two sequential PDSA QI cycles. The overall error rate decreased from 27.2% at baseline to 20.1% in PDSA cycle 1 and further to 9.0% in cycle 2. The proportion of prescriptions with at least one error dropped from 24.2% to 8.6%, reflecting a progressive enhancement in prescribing safety within a resource-constrained outpatient pediatric setting.

These findings are consistent with both national and international evidence highlighting the efficacy of structured QI methodologies in improving medication safety. In India, Gupta et al. reported a reduction in outpatient pediatric prescription errors from 72.2% to 22.5% using a similar two-cycle PDSA model.[6] Mondal et al achieved a reduction from 63% to 10.4% in a neonatal intensive care unit using digital prescriptions, supervision, and standardized formats.[7] These parallels underscore the adaptability and effectiveness of QI models in varying pediatric contexts.

International studies reinforce these findings. A systematic review of pediatric emergency departments (EDs) reported a 10-15% medication error rate, with dosing errors accounting for 39-49% of all incidents.[9] Similarly, a multicenter Spanish study across pediatric EDs found that two-thirds of medication errors occurred at the prescribing stage, with dosing issues being most frequent.[10] In our study, wrong dose and missing dose were among the most significantly reduced error types, suggesting that targeted interventions like checklist-based formats and educational sessions can effectively mitigate common prescribing pitfalls.

The marked improvement in documentation completeness, especially the reduction in missing dose and duration errors, suggests improved adherence to structured prescription protocols. Duration errors were eliminated entirely in PDSA-1, while missing dose errors decreased from 1.69% to 0.41%, indicating that even low-cost analog strategies can yield meaningful results in high-pressure, high-volume OPD settings.

Generic prescription accuracy also improved, with errors declining from 12.35% to 3.69%. This reflects the effectiveness of resident sensitization and audit-feedback loops, which not only reinforce rational drug use but also align with national objectives such as India's "Jan Aushadhi" program promoting generic drug utilization.

However, the minimal change in wrong drug errors despite overall improvement highlights a critical limitation of checklist and education-based interventions in addressing more complex cognitive errors. These findings are echoed in global literature. Alghamdi et al reported persistent rates of wrong drug errors (14-24%) in pediatric intensive care units despite advanced health systems.[12] A US hospital study with computerized physician order entry (CPOE) showed a decline in overall errors over five years, but emphasized the need for continual CPOE optimization, particularly for high-alert medications like antibiotics and antivirals.[13]

Notably, a Chinese study involving 40,000 pediatric OPD prescriptions demonstrated that pharmacist-supervised, pre-prescription electronic screening reduced error rates to 4.3%, with dose errors accounting for 27%.[14] This aligns with meta-analytic findings suggesting that bundled interventions, especially those combining digital tools and pharmacist oversight, are more effective than educational interventions alone.[15]

Run chart analysis and narrowing confidence intervals in our data reflect not only a reduction in mean errors but also improved consistency and reliability in prescribing behavior. This suggests a potential shift in prescribing culture among junior residents, driven by structured reinforcement and continuous feedback.

Despite these gains, a modest reappearance of errors in PDSA-2, particularly in dose and duration—signals the need for ongoing vigilance. As highlighted by Prakadeesh Bharathi et al medication safety encompasses the entire medication-use process, including transcription and administration.[16] Expanding QI efforts beyond prescribing to include these additional stages could further improve pediatric medication safety.

Finally, the absence of digital prescribing systems or clinical pharmacists in our study setting limited our ability to address wrong drug errors effectively. However, a short intervention period in our study has limited insight into long-term sustainability. Regular audits, online surveys and workshops might ensure long-term impact on reducing or eliminating prescription errors in low-resource settings. Future initiatives may benefit from incorporating clinical decision-support systems, CPOE platforms, or pharmacist co-signature models, particularly for complex diagnostic or therapeutic decisions.

CONCLUSION

This study adds to the growing body of national and international evidence that structured, low-cost QI interventions can substantially reduce pediatric prescription errors, even in low-resource settings. While

analog approaches such as standardized formats and educational interventions are highly effective for improving documentation and dosage accuracy, persistent challenges like wrong drug errors may require more sophisticated, system-level solutions. Integrating technology with human oversight through a bundled approach is likely the next frontier in advancing pediatric medication safety across all healthcare settings.

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Ethical approval: The study was approved by the Institutional Ethics Committee

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