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Medication alert records associated with inpatient prescriptions and medication orders in a ward specializing in spleen and stomach diseases: A retrospective descriptive study

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Abstract: **Background**: Computerized medication-review systems generate alerts that may reflect clinically important medication risks as well as rule-setting order-entry or incomplete-information issues. Characterizing these alerts may help prioritize pharmacist review. **Objectives**: To characterize the distribution of medication alert records generated by a computerized pre-prescription review system for inpatient prescriptions and medication orders in a ward specializing in Spleen and Stomach Diseases at Jinhua Hospital of TCM, Affiliated with Zhejiang Chinese Medical University and to identify priorities for optimizing prescription review and medication management. **Methods**: A single-center retrospective descriptive study was conducted using de-identified, aggregated data exported from the rational medication management system at Jinhua Hospital of TCM, affiliated with Zhejiang Chinese Medical University, for the period from 1 January to 30 June 2026. Prescription and medication-order entries and medication-alert entries were summarized by month; medication-alert entries were also summarized by medication, alert category and alert message. **Results**: A total of 23,820 prescription and medication-order entries and 2,998 alert entries were identified, corresponding to an alert-entry rate of 12.59% (2,998/23,820). The most frequent alert categories were dosage and administration (n = 568, 18.95%), route of administration (n = 539, 17.98%), duplicate medication use (n = 499, 16.64%) and indication (n = 447, 14.91%). The medications with the highest absolute numbers of alert entries included Changyanning granules, Ilaprazole sodium for injection and simethicone emulsion. **Conclusion**: Medication alerts showed ward-specific patterns that may identify priorities for pharmacist review and future rule optimization. However, alert entries do not confirm inappropriate prescribing or patient harm and the proposed framework was not implemented or evaluated.

Keywords: Chinese traditional; Clinical; Decision support systems; Hospital; Inpatients; Medicine; Medication review; Pharmacy service

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INTRODUCTION

Hospitalized patients often receive multiple medications, increasing the risk of medication-related problems such as inappropriate indications or dosing, duplicate medication use, inappropriate routes of administration and incompatibilities. Patients in wards specializing in Spleen and Stomach Diseases commonly receive acid-suppressive agents, gastrointestinal motility agents, antimicrobials, Chinese patent medicines and traditional Chinese medicine injections; this polypharmacy makes systematic medication review important (Visaggi *et al*., 2024; Hodkinson *et al*., 2020; Manias *et al*., 2020; Zhang *et al*., 2024).

Medication reviews can identify medication-related problems in hospitalized patients and recent evidence suggests that structured reviews may reduce hospital readmission (Degen *et al*., 2025; Costello *et al*., 2023). The ward pharmacy of Jinhua Hospital of TCM, affiliated with Zhejiang Chinese Medical University, had accumulated medication-alert records during routine practice, but these records had not been systematically characterized. The study was therefore designed to establish a ward-specific baseline to support local medication-management decisions and identify recurrent alert domains for pharmacist review and future rule optimization. The study was not designed to estimate population-level prescribing risk or causal effects. Because computerized medication alerts may reflect clinically important risks as well as problems with rule configuration, order entry or incomplete information (Smith *et al*., 2024; Jin *et al*., 2024; Lampe *et al*., 2024), they were treated as potentially clinically relevant review signals rather than confirmed medication errors. Alert counts alone cannot establish clinical significance. Medication-alert records associated with inpatient prescriptions and medication orders in a ward specializing in Spleen and Stomach Diseases from 1 January to 30 June 2026 were retrospectively analyzed.

Accordingly, a six-month, single-center retrospective descriptive audit was conducted to establish a ward-specific baseline of medication-alert entries in the study ward. Alert-entry burden, alert categories, medications with the highest absolute alert-entry counts, medication–alert combinations and recurrent alert messages were described and candidate priorities for local medication-

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review rule assessment were identified. The study was not designed to assess alert appropriateness, medication-specific risk, predictors of alerts, intervention effects or rule-change effects.

MATERIALS AND METHODS

Study design and data source

This single-center retrospective descriptive study used de-identified, aggregated data from the ward pharmacy's rational medication management system at Jinhua Hospital of TCM, Affiliated with Zhejiang Chinese Medical University. All inpatient prescription and medication-order entries and medication-alert entries exported for the study ward and covering the period from 1 January to 30 June 2026 were included. The units of analysis were entries rather than patients or clinically adjudicated medication-related problems; one prescription or medication-order entry could generate multiple alert entries, each retained as a separate system-generated record. No patients' names, medical record numbers, national identification numbers or other directly identifiable information were collected. No patient-level clinical linkage, pharmacist adjudication, prescriber assessment or outcome linkage was available. Therefore, the study could not determine whether an individual alert represented inappropriate prescribing, a clinically appropriate decision or a false-positive system notification.

Medication-alert system and rule framework

The iPharmCare rational medication use system (version 4.0.241227) generated medication alerts for the ward pharmacy at Jinhua Hospital of TCM, affiliated with Zhejiang Chinese Medical University. The medication-review rules were based on approved product information, the Pharmacopoeia of the People's Republic of China: Clinical Medication Instructions (Chinese Pharmacopeia Commission, 2020) and relevant clinical medication guidelines and were updated when relevant product information was revised. The book is cited as a general reference for the system's medication-review rules rather than as the source of a specific passage or individual rule. The system classified alert risk into five levels, from Level 1 (lowest) to Level 5 (highest). In this study, alerts were analyzed as exported records; rule sensitivity, specificity, predictive value or clinical appropriateness were not independently validated and structured data on alert overrides, pharmacist verification or prescriber responses were unavailable.

A single-center retrospective design was selected to characterize routinely generated medication-alert records within a defined specialty and time period while maintaining relatively consistent formulary, alert-rule configuration and medication-review workflow. The retrospective design enabled assessment of eligible routine records without altering prescribing or medication-review processes and served as a pragmatic first step before patient-level validation and multicenter research.

Data quality control

All eligible records from the prespecified ward and study period were included to minimize selection bias from discretionary sampling. Extracted counts were checked against monthly totals, category totals and the overall number of medication-alert entries; records lacking a predefined classification were retained as unclassified. These checks reduced selection and aggregation errors but could not eliminate residual information or classification bias without patient-level clinical validation.

Methods

Data were summarized by month, medication name, alert category, alert message and record count. The overall alert-entry rate was calculated as follows:

Alert-entry rate (%) = number of medication-alert entries/number of prescription and medication-order entries × 100%.

Monthly alert-entry counts and prescription and medication-order counts were obtained from the same original system export for the study ward during the study period. Because one prescription or medication-order entry could generate multiple medication-alert entries, the rate represented system-generated alert-entry burden relative to prescription and medication-order entry volume, not the proportion of patients or orders with alerts or a medication-error rate.

Category composition was calculated as the number of alert entries in each category divided by the total number of medication-alert entries. Medications and alert messages were ranked by associated alert-entry counts. Counts were expressed as n and percentages (%). Data were exported to Microsoft Excel 16.111 (Microsoft Corporation, Redmond, WA, USA) and analyzed descriptively. No inferential time-trend test or time-series model was performed and predictors of alerts were not evaluated because patient-level and order-level covariates were unavailable. Alert appropriateness, rule performance, overrides, pharmacist interventions, prescriber responses, prescription changes and patient-level outcomes were not assessed. The data extraction and analysis workflow is shown in figure 1.

RESULTS

Overall alert-entry burden and monthly distribution

Between January and June 2026, 23,820 inpatient prescription and medication-order entries and 2,998 medication-alert entries were recorded in the study ward. The overall alert-entry rate was 12.59%. Because one prescription or medication-order entry could generate multiple medication-alert entries, this rate represented system-generated alert-entry burden relative to prescription and medication-order entry volume, not the proportion of patients or orders with alerts or a medication-error rate. Monthly alert-entry rates ranged from 9.92% to 14.37%, with the highest rate in April (14.37%) and the lowest in March (9.92%) (Table 1).

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Fig. 1: Workflow for data extraction and analysis. Note: De-identified, aggregated records exported from the rational medication management system for the ward specializing in Spleen and Stomach Diseases and covering January to June 2026 were organized by month, alert category, medication and alert message. One prescription or medication-order entry could generate multiple alert entries.

Table 1: Monthly distribution of inpatient medication-alert entries in the ward specializing in Spleen and Stomach Diseases from January to June 2026.

Month	Inpatient prescription and medication-order entries	Medication-alert entries	Medication-alert entry rate (%)
January 2026	3942	564	14.31
February 2026	2818	358	12.70
March 2026	5456	541	9.92
April 2026	4107	590	14.37
May 2026	4252	547	12.86
June 2026	3245	398	12.27
Total	23820	2998	12.59

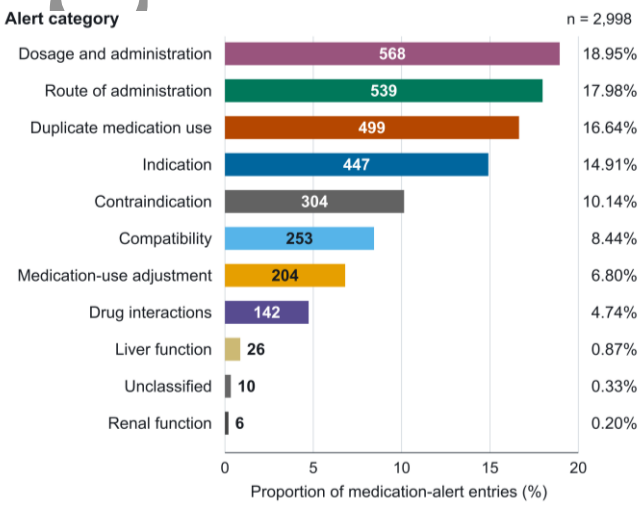


Fig. 2: Distribution of medication-alert categories in the ward specializing in Spleen and Stomach Diseases. Note: Numerical labels indicate alert-entry counts; percentages are based on all 2,998 medication-alert entries. Because one prescription or medication-order entry could generate multiple alerts, these percentages describe alert-entry composition, not patient/order-level alert proportions or medication-error rates.

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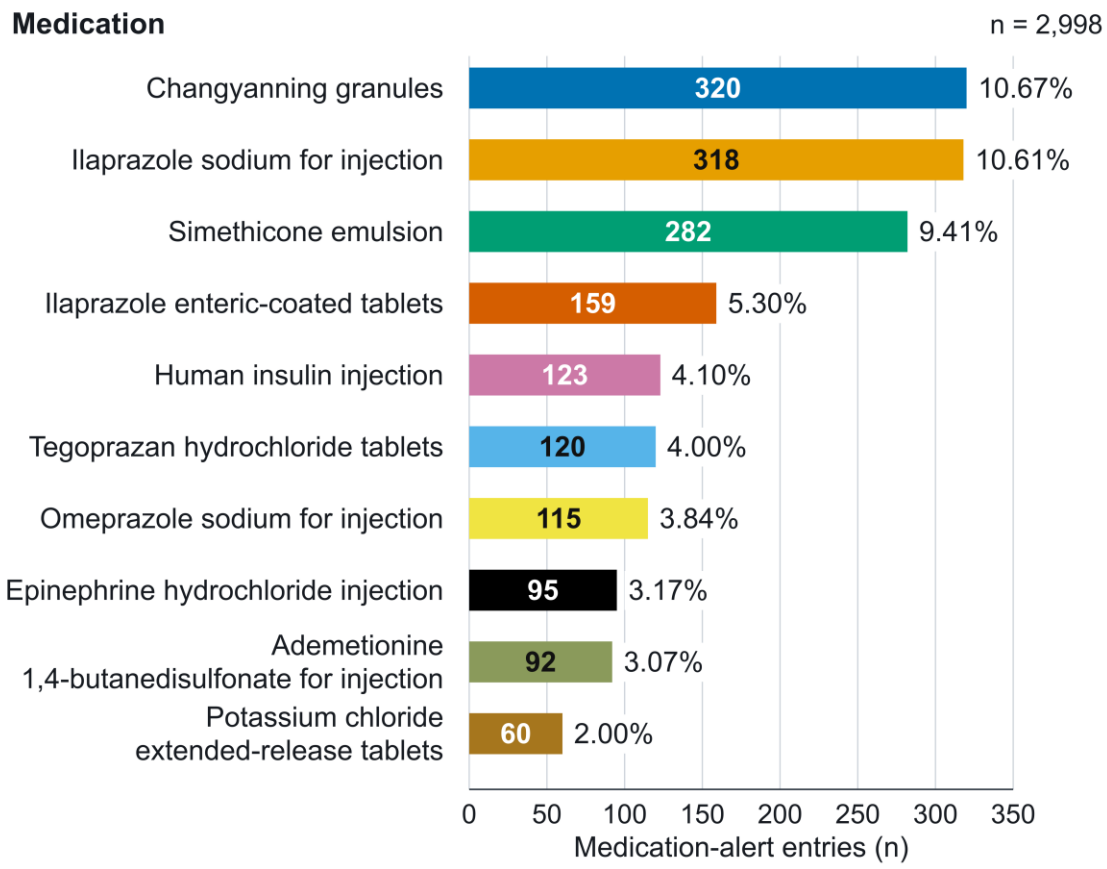


Fig. 3: Medications with the highest absolute numbers of medication-alert entries. Note: Values inside bars are alert-entry counts and percentages are based on all 2,998 medication-alert entries. The top 10 medications are ranked by absolute alert-entry counts, not medication-specific alert rates or prescribing risk, because medication-use denominators were unavailable.

Distribution of medication-alert categories

When classified by alert category, the most frequent categories were dosage and administration, route of administration, duplicate medication use and indication. Together, these four categories accounted for 68.48% of all medication-alert entries (Fig. 2).

Medications with the highest absolute numbers of alert entries

After aggregation by medication name, figure 3 shows the 10 medications with the highest absolute alert-entry counts. Because medication-specific prescribing, medication-order and administration denominators were unavailable, these counts cannot be interpreted as medication-specific alert rates, prescribing-risk rankings or evidence of medication inappropriateness.

Most frequent medication-alert messages and associated medications

After aggregation by alert message, the most frequent messages concerned indication, duplicate medication use, route of administration and dosing frequency. Table 2 shows the 10 most frequent messages and associated medications.

Frequent medication–alert category combinations

The frequent medication–alert category combinations involved indication, route of administration, medication-use adjustment, dosage and administration and duplicate medication use. Indication-related alerts for Changyanning granules were the most frequent, followed by route-of-administration alerts for simethicone emulsion and medication-use adjustment alerts for Ilaprazole sodium for injection (Fig. 4).

DISCUSSION

Principal findings

In this six-month, single-center retrospective descriptive audit, dosage and administration, route of administration, duplicate medication use and indication accounted for 68.48% of all alert entries. This distribution identifies candidate priorities for local medication-review rule assessment but does not represent the prevalence of medication errors or clinically inappropriate prescribing.

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Table 2: Ten most frequent medication-alert messages and associated medications.

Rank	Alert category	Most frequent medication-alert message	Alert entries (n)	Percentage of all medication-alert entries (%)
1	Indication	Changyanning granules are indicated for diseases associated with damp-heat accumulation in the middle jiao or damp-heat in the lower jiao; use outside the approved indications is not recommended.	317	10.57
2	Duplicate medication use	Multiple current medication orders were issued for the same hospitalized patient.	290	9.67
3	Route of administration	The route of administration for simethicone emulsion is inappropriate; it should be administered orally, by nasogastric feeding or through a fistula tube.	282	9.41
4	Dosage and administration	The dosing frequency is inappropriate; this product should be administered once daily.	258	8.61
5	Medication-use adjustment	Ilaprazole sodium for injection is indicated for upper gastrointestinal bleeding, gastric ulcer bleeding and related conditions; if no relevant diagnosis is documented, it should be used according to the institutional procedure for off-label use.	197	6.57
6	Dosage and administration	The dosing frequency of ilaprazole enteric-coated tablets is inappropriate; the product should be administered once daily.	149	4.97
7	Duplicate medication use	The current medication and another medication both belong to the proton pump inhibitor class; duplicate therapy should be avoided.	146	4.87
8	Compatibility	Only drugs known to be compatible may be added to insulin preparations; mixing with other drugs is prohibited.	93	3.10
9	Contraindication	Epinephrine hydrochloride injection is contraindicated in patients with hypertension.	79	2.64
10	Route of administration	The route of administration is inappropriate; the product should be administered by intravenous infusion, using an infusion pump or by intramuscular injection.	62	2.07

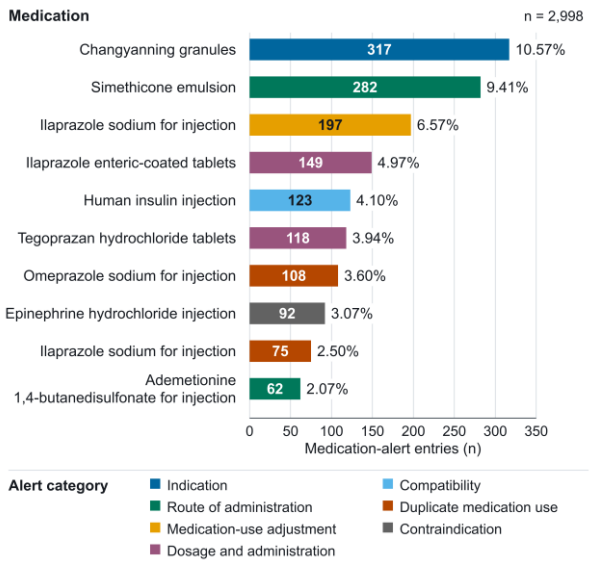


Fig. 4: High-frequency medication–alert category combinations. Note: Values inside bars are counts and percentages are based on all 2,998 medication-alert entries. The figure shows the 10 most frequent medication–alert category combinations; the same medication may appear more than once because it may be associated with different alert categories.

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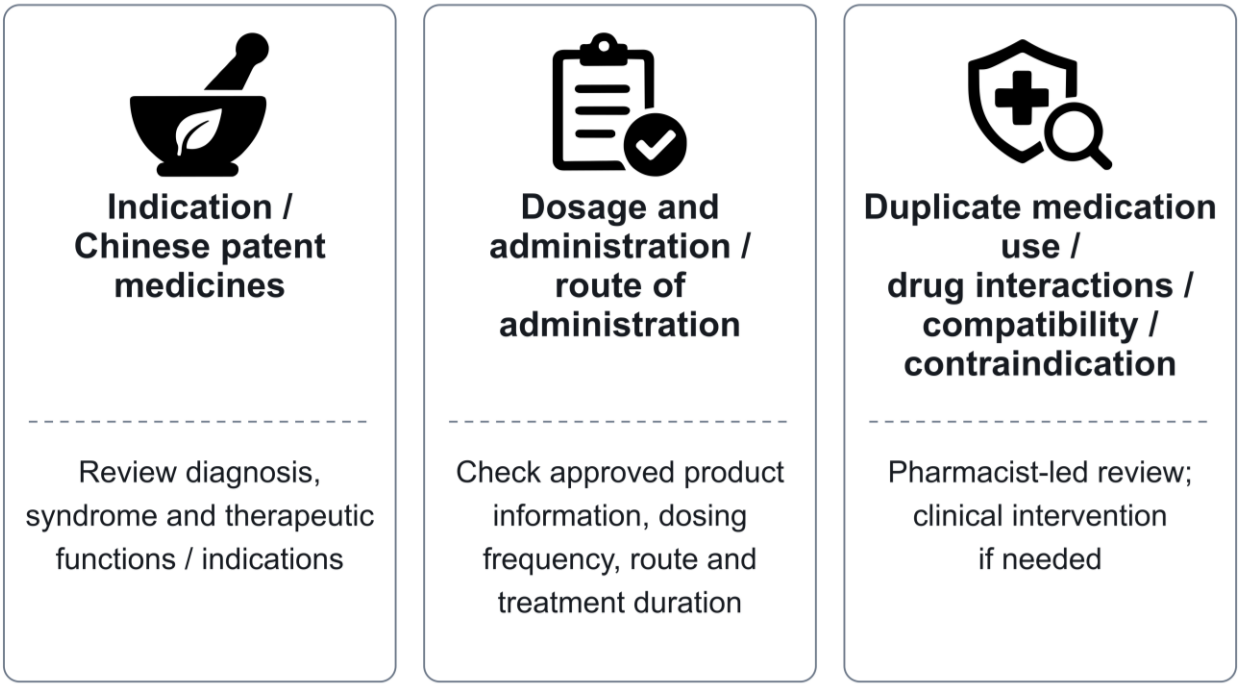


Fig. 5: Proposed integrated, tiered medication-alert management framework for future evaluation
Note: This conceptual framework is proposed for future evaluation and has not been implemented or validated. The three panels represent indication review, dosage/route review and pharmacist-led review of duplicate therapy, drug interactions, compatibility and contraindications.

Because patient-level clinical adjudication was unavailable and alerts may also reflect rule configuration, incomplete documentation or order-entry issues (Ledger *et al*., 2023; Jin *et al*., 2024; Lampe *et al*., 2024), the findings should be interpreted as a ward-specific baseline for hypothesis generation and future validation.

Comparison with previous studies

Compared with prior studies that have assessed alert appropriateness, prescriber responses and alert optimization (Alsaidan *et al*., 2022; Jin *et al*., 2024; Ledger *et al*., 2023; Ng *et al*., 2023), the present study provides a context-specific descriptive baseline from the study ward at Jinhua Hospital of TCM, Affiliated with Zhejiang Chinese Medical University, by summarizing alert-entry burden, alert categories, recurrent alert messages and medication–alert combinations. Its contribution is local and descriptive rather than a methodological innovation, a generalizable prescribing-risk estimate or a causal evaluation.

Implications for pharmacist review and medication-alert rule optimization

The predominance of dosage- and administration-related alerts may inform a ward-specific checklist addressing the indication, dose, frequency, duration, relevant renal or hepatic considerations and consistency with approved product information or institutional protocols. Whether pharmacist verification, dual signatures or prescriber feedback are appropriate for selected medicines under institutional policy should be evaluated. This approach is consistent with prior medication-safety research (Degen *et al*., 2025; Alsaidan *et al*., 2022).

Route-of-administration alerts were also prominent, with simethicone emulsion accounting for a notable proportion of these alerts. This finding should be interpreted in the context of the intended clinical use, the examination or treatment scenario and the route actually planned for administration. A route alert should not be classified as a prescribing error solely based on system output. The pharmacy team and the clinical team in the study ward should review whether the electronic order set provides appropriate route options for common clinical scenarios, including relevant enteral administration and should revise order templates or data fields when repeated alerts result from inconsistent documentation. Post-implementation optimization of alert rules and order-entry systems may reduce low-value alerts while preserving alerts with potential clinical significance (Ledger *et al*., 2023; Jin *et al*., 2024; Ng *et al*., 2023; McCoy *et al*., 2022).

Alerts for duplicate medication use mainly reflected repeated orders for the same medicine and overlapping acid-suppressive therapy. Future clinical review could assess the indication, therapeutic intent, formulation, route, need for intravenous treatment, dosing frequency, duration and concurrent acid-suppressive therapy. Long-term or

unnecessarily intensive proton-pump inhibitor therapy may warrant reassessment, with deprescribing or step-down therapy considered when clinically appropriate (Targownik *et al*., 2022; Mari *et al*., 2023).

Indication-related alerts were particularly frequent for Changyanning granules, a pattern that may reflect frequent use and limitations in electronic indication dictionaries for traditional Chinese medicine rather than inappropriate prescribing. Product-specific review should consider the labeled indication, diagnosis and symptoms, therapeutic purpose, contraindications, dose, duration and concomitant therapy; prior evidence suggests that the effectiveness and safety profiles of Chinese medicinal products vary across products and gastrointestinal conditions (Niu *et al*., 2023; Zhang *et al*., 2024). Such a review may help distinguish clinically supported use from alerts caused by incomplete indication mapping.

Proposed integrated, tiered medication-alert management framework

Taken together, these domains provide a basis for a proposed integrated, tiered framework in which safety-critical signals receive prioritized pharmacist review, context-dependent signals undergo clinical verification and documentation and rule-related alerts are addressed through order-template or rule optimization (Fig. 5). This framework is a hypothesis for future evaluation rather than a validated intervention.

Future recommendations

Future studies should link medication-alert records with de-identified patient- or medication-order episodes, obtain medication-use denominators and apply predefined clinical-adjudication criteria independently by at least two pharmacists or clinicians. They should also record pharmacist interventions, prescriber responses, alert overrides, prescription changes and clinical outcomes. Larger datasets with patient- or order-level variables and day-level timestamps would support analyses of predictors and temporal patterns. At the same time, prospective evaluation of revised alert rules or a tiered workflow should assess alert appropriateness, intervention rates, prescriber acceptance, alert burden and patient outcomes.

Study limitations

Several limitations should be considered. First, this single-center study covered one specialty ward over six months, with only six monthly aggregate observations and no day-level timestamps, limiting generalizability and formal temporal inference. Second, the entry-level aggregated dataset lacked patient-level clinical linkage, clinical adjudication, medication-use denominators and process or outcome data; consequently, alert appropriateness, medication-specific risk, pharmacist or prescriber responses, prescription changes or patient outcomes could not be assessed. Third, patient- and order-level covariates were unavailable, precluding predictor analyses. Alert-rule performance was not independently validated and the proposed tiered framework was not evaluated. Residual information and classification bias cannot be excluded.

CONCLUSION

This six-month, single-center retrospective descriptive audit identified 2,998 medication-alert entries among 23,820 inpatient prescription and medication-order entries in the study ward, corresponding to an alert-entry rate of 12.59%. Dosage and administration, route of administration, duplicate medication use and indication were the four leading alert categories and together accounted for 68.48% of all alert entries. Changyanning granules, Ilaprazole sodium for injection and simethicone emulsion were among the medicines with the highest absolute alert-entry counts; however, these counts should not be interpreted as medication-specific risk rankings because medication-use denominators were unavailable. The findings provide a ward-specific descriptive baseline that may help prioritize future clinical validation, pharmacist review and local medication-review rule assessment.

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None.

Authors' contributions

Shiqi Qian performed all aspects of the study, including conceptualization, methodology, data curation, formal analysis, visualization and manuscript writing. The author approved the final version of the manuscript and agrees to be accountable for all aspects of the work.

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Data availability statement

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

Ethical approval

The Ethics Committee of Jinhua Hospital of TCM, Affiliated with Zhejiang Chinese Medical University, reviewed this study. The Committee determined that the study qualified for a waiver of ethical review because it was a retrospective, non-interventional study based on de-identified and aggregated medication-alert records obtained from the hospital's rational medication management system. The study did not involve prospective patient recruitment, alteration of patients' treatment plans or clinical intervention. The Committee also waived the informed consent requirement. No patients' names, medical record numbers, national identification numbers, contact information or other directly identifiable personal information were collected or analyzed (Ethics Waiver No.:

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Not applicable; waiver decision date: 10 July 2026). This study was performed in adherence with the RECORD guidelines. See supplementary file for the RECORD checklist.

Consent to publication

Not applicable. This study used de-identified, aggregated data and did not include identifiable personal information, clinical details or images. The manuscript is original, has not been published previously in any language or format and is not currently under consideration elsewhere.

Conflicts of interest

The authors declare no conflict of interest.

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