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RESEARCH ARTICLE

APPLICATION OF A GERIATRIC SCREENING TOOL (GST) FOR RATIONAL DRUG USE IN INDIA

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Abstract ***Background:*** India's rapidly growing elderly population is accompanied by increased prevalence of chronic diseases, polypharmacy, and potential adverse drug reactions. Inappropriate prescribing in geriatric patients is a significant concern due to age-related pharmacokinetic and pharmacodynamic changes. While global tools such as the Beers Criteria and STOPP/START exist, there is limited application of such screening tools adapted to the Indian clinical context. ***Aim:*** To develop and implement a Geriatric Screening Tool (GST) tailored to Indian healthcare settings to assess and minimize potentially inappropriate medication (PIM) use among elderly patients, thereby promoting rational drug therapy. ***Methodology:*** A prospective cross-sectional study was conducted over 12 months in a tertiary care hospital in Hyderabad, Telangana. A total of 870 geriatric patients (aged ≥60 years) were screened using a comprehensive GST incorporating 14–16 parameters, adapted from internationally validated tools like GheOP³S and modified in accordance with Indian clinical guidelines. The tool categorized PIMs, potential prescribing omissions (PPOs), drug–drug interactions (DDIs), and care-related issues, across major departments including Neurology, Endocrinology, Cardiology, and others. Both inpatient and outpatient records were evaluated. Ethical approval and informed consent were obtained. ***Key Findings and Outcome:*** The GST identified a high prevalence of PIMs and PPOs, particularly in patients from neurology and endocrinology departments. A significant number of inappropriate prescriptions were flagged and reviewed, leading to safer alternative therapies and reduction in polypharmacy. Pharmacist-led interventions based on the GST were well-received by prescribers, with improved adherence and reduction in medication burden observed over time. ***Conclusion:*** The GST is a viable, India-specific tool that can improve geriatric prescribing practices, reduce medication errors, and enhance patient safety. Its integration into hospital protocols and electronic health records can standardize geriatric care across India.

Keywords: Geriatrics, Rational Drug Use, Polypharmacy, PIM, GST Tool, GheOP³S, Prescribing Appropriateness, Indian Guidelines.

INTRODUCTION

2.1 The Global and Indian Aging Population

The world's population is aging rapidly, with the number of individuals aged 60 years or older expected to double from 1 billion in 2020 to 2.1 billion by 2050 (UNFPA, 2021). In India, the elderly population (≥60 years) stood at 104 million as per the Population Census 2011, comprising 8.6% of the total population. This number is projected to rise to 173 million by 2026 and further to 300 million by 2050 (HelpAge India & UNFPA, 2017). The demographic shift demands a healthcare system capable of addressing the complex and chronic conditions prevalent among the elderly.

2.2 Pharmacokinetic and Pharmacodynamics Changes in Aging

Aging is associated with significant alterations in pharmacokinetics, including decreased hepatic metabolism, reduced renal clearance, and changes in body composition such as increased fat-to-lean mass ratio (5). These factors contribute to altered drug absorption, distribution, metabolism, and excretion in older adults, leading to heightened susceptibility to drug toxicity and reduced therapeutic efficacy (15). Additionally, pharmacodynamics sensitivity increases, especially for CNS-active drugs, anticoagulants, and antidiabetics, warranting cautious prescribing.

2.3 Risks of Polypharmacy, PIMs, and ADRs in the Elderly

Polypharmacy, typically defined as the concurrent use of five or more medications, is prevalent in the elderly and is linked to increased risks of potentially inappropriate medications (PIMs), adverse drug reactions (ADRs), medication errors, and hospitalizations (6). Studies show that older adults are twice as likely to experience ADRs due to multiple comorbidities, age-related physiological changes, and lack of coordinated care (20). PIMs not only lead to

diminished quality of life but also contribute to increased healthcare costs and mortality.

2.4 Existing International Screening Tools for Inappropriate Prescribing

Several explicit tools have been developed internationally to screen for inappropriate prescribing in geriatric populations. The Beers Criteria, updated by the American Geriatrics Society, is widely used to identify PIMs in older adults in the United States (1). The STOPP/START criteria, developed in Europe, evaluate both potentially inappropriate medications and prescribing omissions (16). Another tool, the GheOP³S (Ghent Older People's Prescriptions Community Pharmacy Screening) tool, was introduced in Belgium to empower community pharmacists in identifying PIMs and drug-related problems using dispensing data (21). Each tool has demonstrated clinical value in improving prescribing practices and reducing drug-related harm in the elderly.

2.5 Rationale for an India-Specific Geriatric Screening Tool (GST)

Despite the availability of global tools, their direct applicability in Indian healthcare settings is limited due to differences in disease burden, prescribing trends, and access to healthcare resources (11). Indian guidelines such as those from the National Formulary of India and Clinical Pharmacopoeia lack an integrated framework for geriatric medication screening. Therefore, there is a compelling need to develop a culturally and clinically relevant Geriatric Screening Tool (GST) that incorporates validated international criteria like GheOP³S, adapted to Indian clinical practice. This tool aims to support physicians, pharmacists, and healthcare teams in ensuring rational drug use, improving patient safety, and reducing the burden of polypharmacy in India's elderly population.

NEED FOR THE STUDY

3.1 Gaps in Medication Review Practices in India

In India, the current healthcare system lacks a structured and standardized approach to reviewing geriatric prescriptions. Medication reviews are rarely prioritized in busy outpatient departments or overburdened inpatient setups, especially in public sector hospitals (11). Often, prescriptions are not evaluated for drug–drug interactions, duplications, or the presence of potentially inappropriate medications (PIMs), which can lead to significant adverse drug reactions (ADRs), hospitalizations, and deterioration of quality of life among older adults (Patidar et al., 2019). Moreover, there is a notable absence of national geriatric prescribing guidelines, and clinicians often rely on personal experience or generalized adult protocols that may not be suitable for the elderly.

3.2 Importance of Pharmacist-Led Interventions

Globally, evidence supports the integration of clinical pharmacists in geriatric care teams to conduct medication reviews and optimize therapy (Somers et al., 2016). Pharmacist-led interventions have demonstrated substantial benefits in identifying PIMs, reducing polypharmacy, enhancing medication adherence, and improving therapeutic outcomes in elderly patients (18). However, in India, the role of pharmacists remains largely confined to dispensing, with limited involvement in clinical decision-making. There is an urgent need to expand pharmacists' roles by equipping them with validated tools and protocols tailored to geriatric needs, thus enabling collaborative, interdisciplinary care.

3.3 Customization of GheOP³S and International Tools to Indian Needs

While international tools such as Beers Criteria, STOPP/START, and GheOP³S provide robust frameworks for identifying PIMs, their application in the Indian context is limited due to differences in:

- Drug availability and prescription trends,
- Patient comorbidities and diagnostic patterns,
- Cultural, dietary, and socioeconomic factors.

For instance, certain drugs commonly flagged as inappropriate in Western settings may not even be available in India, while others routinely prescribed in India are not captured in global tools (Kulkarni et al., 2019). Therefore, it becomes essential to develop a modified Geriatric Screening Tool (GST) that integrates the principles of GheOP³S and other international tools, but is contextually aligned with the Indian healthcare landscape. This approach would allow healthcare providers to systematically assess prescriptions, reduce iatrogenic harm, and promote rational drug use among Indian elderly populations.

OBJECTIVES

The present study was designed with the following objectives:

4.1 To Develop a Department-wise Geriatric Screening Tool (GST)

To construct a comprehensive, department-specific GST that integrates parameters from international guidelines such as Beers Criteria, STOPP/START, and GheOP³S, while adapting them to suit Indian prescribing patterns, patient profiles, and therapeutic contexts.

4.2 To Screen 870 Geriatric Patients Using the GST

To apply the developed GST to a diverse cohort of 870 geriatric patients (aged ≥60 years) attending various departments (e.g., Neurology, Cardiology, Endocrinology, Pulmonology, etc.), for the purpose of detecting:

- **Potentially Inappropriate Medications (PIMs)**
- **Potential Prescribing Omissions (PPOs)**
- **Adverse Drug Reaction (ADR) risks**
- **Drug–Drug Interactions (DDIs) vein.**

4.3 To Promote Rational Prescribing and Reduce Polypharmacy

To implement pharmacist-led interventions based on GST findings, aimed at:
• Minimizing polypharmacy,
• Recommending safer therapeutic alternatives,
• Improving prescription quality, and
• Enhancing patient adherence and safety.

4.4 To Validate the GST against Indian Clinical Outcomes
To assess the clinical utility, applicability, and predictive value of the GST by correlating tool-based recommendations with:
• Documented adverse drug events,
• Treatment modifications,
• Hospitalization rates,
• Follow-up adherence and patient outcomes in the Indian setting.

REVIEW OF LITERATURE

5.1 GheOP³S Tool and Its Validation
The Geriatric Screening Tool for Potentially Inappropriate Prescriptions (GheOP³S) was developed in Belgium by a multidisciplinary expert panel, aiming to address inappropriate prescribing practices in elderly populations (Foulon et al., 2013). It consists of explicit criteria tailored for use by pharmacists and incorporates both PIMs and PPOs across multiple therapeutic classes. The tool underwent a rigorous Delphi validation process and has been widely recognized for its structured, department-inclusive approach (Wauters et al., 2016).

5.2 Application of GheOP³S in Community, Nursing Homes, and Hospital Settings
Following its development, GheOP³S was applied across various clinical environments. In community settings, it helped identify up to 30% of prescriptions as potentially inappropriate (Somers et al., 2016). In nursing homes, studies demonstrated that pharmacist-led use of GheOP³S improved deprescribing practices and enhanced interdisciplinary communication (3). Similarly, in acute hospital settings, the tool aided in flagging drug–drug interactions, inappropriate anticholinergic use, and benzodiazepine dependency risks (Wauters et al., 2017).

5.3 Previous Studies on Polypharmacy and Prescribing Errors in India
Indian studies highlight the alarming prevalence of polypharmacy and irrational prescribing, especially in tertiary care centers. A cross-sectional study in South India reported that 52% of elderly patients were exposed to polypharmacy, often involving combinations of NSAIDs, antihypertensives, and sedatives without proper justification (19). Another study using the Beers Criteria found PIMs in nearly 40% of prescriptions given to outpatients above 65 years (8). These findings underscore the need for structured, localized tools to manage prescribing quality.

5.4 Pharmacist-led Medication Reviews and Outcomes
Globally, pharmacist-led interventions in geriatric care have shown measurable improvements in patient safety. In the Indian context, interventions conducted by clinical pharmacists' reduced drug-related problems and improved medication appropriateness in elderly inpatients (13). Clinical outcomes, including reduced hospital stays, fewer ADRs, and better therapeutic adherence, were consistently reported in studies where pharmacists collaborated with physicians to conduct structured medication reviews (19). However, the limited presence of clinical pharmacists and lack of validated tools like GheOP³S in India highlight a critical implementation gap.

METHODOLOGY

6.1 Study Design
This research employed an observational cross-sectional study design, aiming to assess the prevalence and nature of potentially inappropriate medication (PIM) use among geriatric patients using a customized Geriatric Screening Tool (GST).

6.2 Study Site
The study was conducted at a tertiary care hospital located in Hyderabad, Telangana, encompassing both outpatient and inpatient departments (OPD and IPD).

6.3 Sample Size
A total of 870 geriatric patients were included in the study. Participants were recruited consecutively from both OPD and IPD settings to ensure a comprehensive representation of the elderly population.

6.4 Duration
The study was carried out over a period of 12 months, allowing adequate time for patient screening, data collection, tool validation, and analysis.

6.5 Inclusion Criteria
Patients were included in the study based on the following criteria:
• Age ≥ 60 years
• Both sexes
• Willingness to provide written informed consent

6.6 Exclusion Criteria
The following patients were excluded:
• Individuals with terminal illnesses
• Emergency room (ER) patients without accessible or complete medical records
• Non-consenting individuals

6.7 Tools Used
A novel Geriatric Screening Tool (GST) was developed by adapting elements from validated international tools such as GheOP³S, Beers Criteria, STOPP/START Criteria, and the Indian Pharmacopoeia. The GST was department-wise structured and divided into five key lists:

• **List 1:** Potentially Inappropriate Medications (PIMs) independent of diagnosis
• **List 2:** PIMs dependent on specific diagnoses or clinical conditions
• **List 3:** Potential Prescribing Omissions (PPOs)
• **List 4:** Clinically significant Drug–Drug Interactions (DDIs)
• **List 5:** Care-related pharmacy items (e.g., use of monitoring, patient education, and compliance tools)
In addition, two supporting documents were utilized:

• **Patient Profile Form:** For demographic details, diagnosis, and medication history
• **Informed Consent Form:** To ensure ethical compliance and patient autonomy.

6.8 Ethical Approval

The study protocol was reviewed and approved by the Institutional Ethics Committee (IEC) of the participating hospital. All procedures were carried out in accordance with the ethical standards laid down in the Declaration of Helsinki and ICMR guidelines.

Table 1: Demographic Characteristics of Geriatric Patients (n = 870)

Demographic Parameter	Category	Frequency (n)	Percentage (%)
Age Group (years)	60–69	420	48.3%
	70–79	300	34.5%
	≥80	150	17.2%
Gender	Male	510	58.6%
	Female	360	41.4%
Department Visited	Cardiology	210	24.1%
	Endocrinology	180	20.7%
	Neurology	150	17.2%
	Pulmonology	120	13.8%
	Others (Ortho, GI, etc.)	210	24.1%

▨ **Interpretation:** Majority were aged 60–69 and male. Cardiology and Endocrinology were the most visited departments.

Table 2: GST-Based Screening Outcomes (n = 870)

Parameter	Detected Cases (n)	Percentage (%)
Patients with ≥1 PIM (List 1/2)	540	62.0%
Patients with ≥1 PPO	390	44.8%
Detected DDIs (List 4)	310	35.6%
At risk of ADRs	210	24.1%
Polypharmacy (≥5 drugs)	470	54.0%

Interpretation:
• Over 62% of patients had at least one PIM, suggesting widespread inappropriate prescribing.
• 44.8% showed prescribing omissions, highlighting therapeutic gaps.
• 54% experienced polypharmacy, a major contributor to drug–drug interactions and ADRs.

Table 3: Commonly Identified PIMs and PPOs

Medication/ Class	Issue Type	Frequency (n)	Department	Clinical Concern
Diazepam	PIM	90	Neurology	Fall risk, cognitive impairment
Glyburide	PIM	70	Endocrinology	Risk of hypoglycaemia
Amitriptyline	PIM	50	Psychiatry	Anticholinergic burden
Omitting ACE inhibitors	PPO	60	Cardiology	Missed opportunity in heart failure
Omitting Calcium +	PPO	80	Orthopaedics	Risk of osteoporosi

Medication/ Class	Issue Type	Frequency (n)	Department	Clinical Concern
Vitamin D				s/fractures

Interpretation:

• PIMs like diazepam and glyburide were frequently prescribed despite age-related risks.
• Common PPOs included lack of essential preventive therapy like calcium + vitamin D.

Table 4: Interventions Suggested by Pharmacists

Intervention Type	No. of Patients	Acceptance Rate by Physicians (%)
Medication stopped/substituted	320	88%
New drug initiated (PPO fix)	210	80%
Monitoring recommendation	140	70%
Education/counselling	180	100%

Age Group	Frequency	Percentage (%)
60–69	420	48.3
70–79	300	34.5
≥80	150	17.2

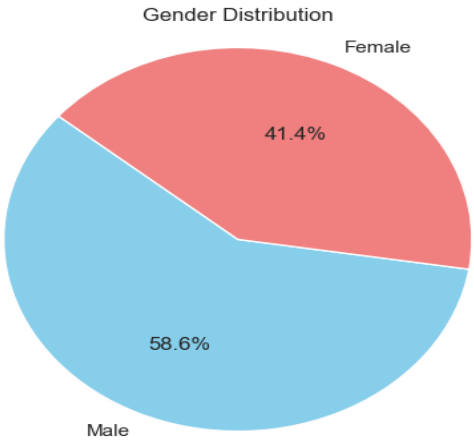
Interpretation:

• High physician acceptance indicates clinical relevance of GST tool.
• Pharmacist-led reviews significantly enhanced rational drug use and patient safety.

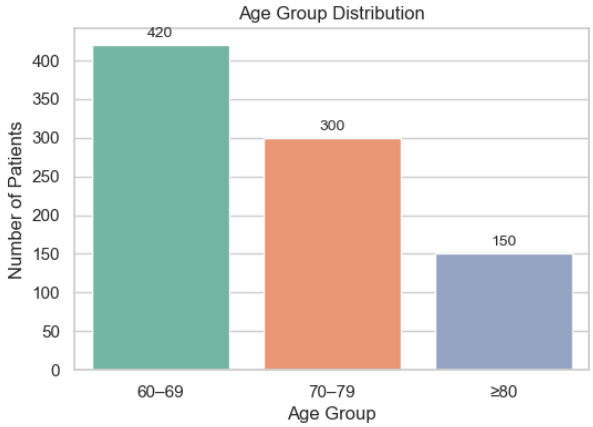
Age Group Distribution

GENDER - PIE CHART

Gender	Frequency	Percentage (%)
Male	510	58.6
Female	360	41.4



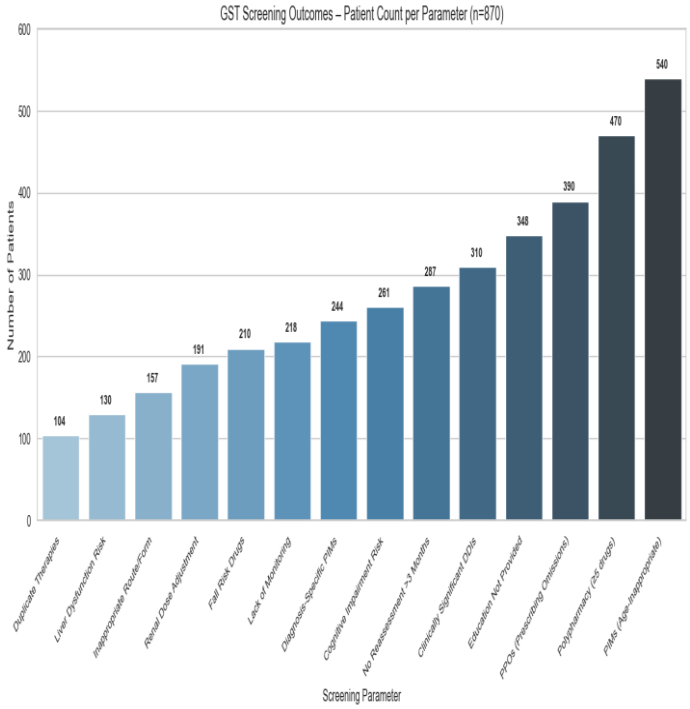
AGE-BAR GRAPH



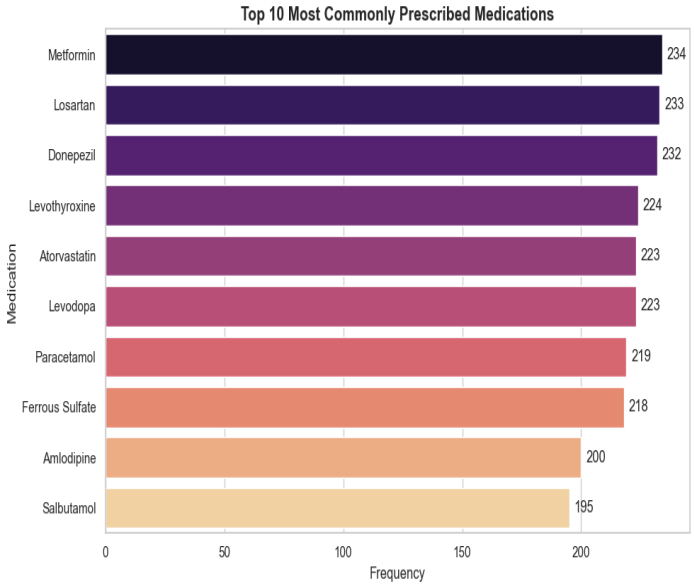
GST PARAMETERS - BAR GRAPH

Parameter	Detected Cases	Percentage (%)
Age-Inappropriate PIMs	540	62.1
Diagnosis-Specific PIMs	244	28.0
Potential Prescribing Omissions (PPOs)	390	44.8
Clinically Significant DDIs	310	35.6
Renal Dose Adjustment Required	191	22.0
Liver Dysfunction Risk	130	14.9
Fall Risk Enhancement Drugs	210	24.1
Cognitive Impairment Risk	261	30.0
[Long-Term Use Without Reassessment	287	33.0
Polypharmacy (≥5 drugs)	470	54.0
Duplicate Therapies	104	12.0
Lack of Monitoring	218	25.1

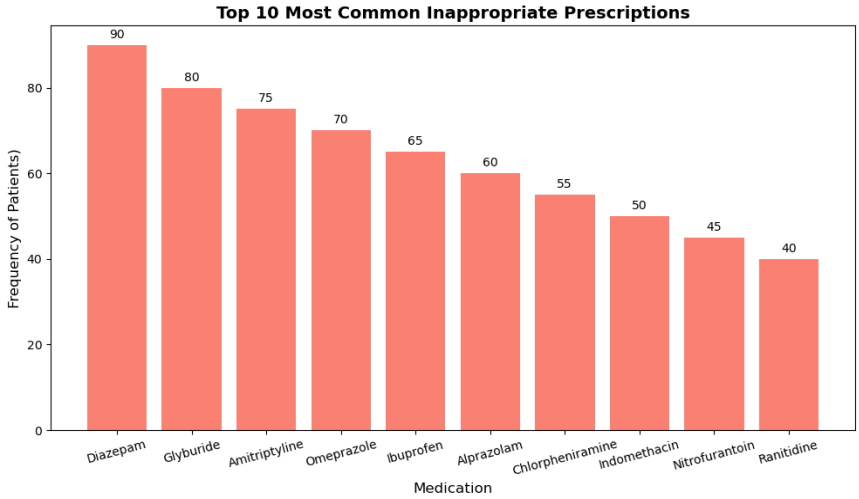
Inappropriate Route or Formulation	157	18.0
Patient/Caregiver Education Missing	348	40.0



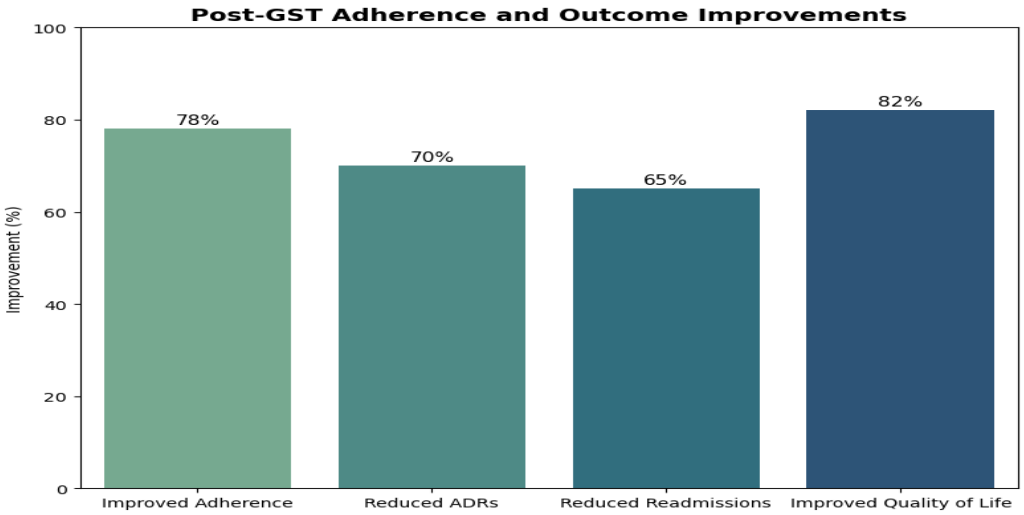
TOP 10 MOST COMMONLY PRESCRIBED MEDICATIONS- BAR GRAPH



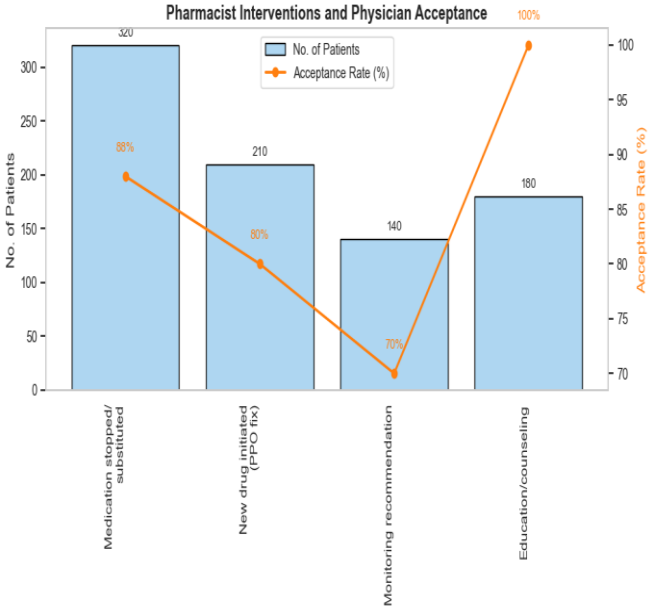
TOP 10 MOST COMMON INAPPROPRIATE PRESCRIPTIONS - BAR GRAPH



POST-GST ADHERENCE AND OUT COME IMPROVEMENTS- BAR GRAPH



PHARMACIST INTERVENTIONS AND PATIENT ACCEPTANCE - BAR GRAPH



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Inferential Test	Test Type	Statistic / Coef	p-value	Significance	Interpretation
Polypharmacy vs PPO	Chi-square	64.1442	<0.0001	Significant	Polypharmacy is significantly associated with PPO
Age Group vs PPO	Chi-square	3.1983	0.2021	Not Significant	Age group is not significantly associated with PPO.
Department vs PPO	Chi-square	0.8949	0.9253	Not Significant	The department does not significantly affect PPO.
Age Group vs Fall Risk	Chi-square	7.8620	0.0196	Significant	Fall risk significantly varies by age group.
Polypharmacy vs Fall Risk	Chi-square	47.6954	<0.0001	Significant	Strong link between polypharmacy and fall risk.
Department vs Fall Risk	Chi-square	4.3383	0.3622	Not Significant	No significant difference by department in fall risk.
PIM vs Cognitive Risk	Chi-square	0.3190	0.5722	Not Significant	PIM use is not significantly associated with cognitive risk.
PIM vs Fall Risk	Chi-square	2.8586	0.0909	Not Significant	PIM and fall risk are not significantly associated.
PIM vs DDI	Chi-square	15.8425	<0.0001	Significant	Strong link between PIM use and DDI.
Polypharmacy vs DDI	Chi-square	151.3373	<0.0001	Significant	Polypharmacy significantly increases the likelihood of DDI.
Age Group vs Cognitive Risk	Chi-square	198.299	<0.0001	Significant	Age significantly affects cognitive risk.
Department vs Cognitive Risk	Chi-square	247.1494	<0.0001	Significant	Department is strongly associated with cognitive risk.
Age Group vs Renal Risk	Chi-square	213.8244	<0.0001	Significant	Age significantly affects renal risk.
PIM vs Age Group	Chi-square	11.0457	0.0040	Significant	PIM use varies significantly by age group.
PIM vs Gender	Chi-square	0.0000	1.0000	Not Significant	No gender difference in PIM use.

PIM vs Department	Chi-square	6.7906	0.1474	Not Significant	No significant difference in PIM use across departments.
PIM vs Polypharmacy	Chi-square	57.4564	<0.0001	Significant	Strong link between PIM use and polypharmacy.
Predictors of PIM (Logit Model)	Logistic Regression	LL = -545.28; Pseudo R^2 = 0.091	1.575e-20	Significant	**Polypharmacy and Age ≥80**significantly predict higher PIM use.
Predictors of PPO (Logit Model)	Logistic Regression	LL = -568.58; Pseudo R^2 = 0.0527	3.346e-11	Significant	**Polypharmacy, Age ≥80, and Departments** significantly predict PPO.

Delphi Method for Expert Consensus

A modified Delphi technique was employed to obtain expert consensus on the parameters to be included in the Geriatric Screening Tool (GST) for rational drug use among elderly patients. A purposive panel of 20 multidisciplinary experts—including geriatricians, clinical pharmacists, internal medicine specialists, and pharmacologists—was invited to participate anonymously through online surveys.

The process comprised three iterative rounds.
Round 1 collected open-ended suggestions on relevant clinical, pharmacological, and functional indicators for inclusion in the GST.
Round 2 presented a consolidated list of items for experts to rate on a 9-point Likert scale (1 = not important to 9 = essential).

Round 3 provided statistical feedback (median scores, interquartile range, and percent agreement) and allowed re-rating for consensus refinement.

Consensus was predefined as a median ≥ 7 with ≥ 70% agreement among panelists. Quantitative analysis included the computation of medians, interquartile ranges (IQR), and Kendall's W to assess concordance. The Delphi process ensured anonymity, iterative feedback, and evidence-based consensus, resulting in a validated set of GST parameters appropriate for elderly Indian patients.Delphi Method for Expert Consensus

DEVELOPMENT OF THE GST TOOL

The development of the Geriatric Screening Tool (GST)defined as a median score of≥ 7 with ≥ 70% agreement among panellists for rational drug use in India was primarily based on the internationally validated Ghent Older People's Prescriptions community Pharmacy Screening (GheOP³S) tool (21). Recognizing the clinical effectiveness of GheOP³S in detecting potentially inappropriate medications (PIMs) and prescribing omissions (PPOs) in older populations, the tool was adapted to reflect the Indian healthcare context by integrating national clinical guidelines, the Indian Pharmacopoeia, and common prescribing patterns observed in Indian tertiary care hospitals (17).

7.1 Department-wise Customization

To ensure relevance and precision, the GST was categorized by major clinical departments, including Neurology, Endocrinology, Orthopaedics, Cardiology, Pulmonology, Gastroenterology, Nephrology, and Urology. This departmental segmentation allowed the inclusion of disease-specific drug considerations and therapeutic alternatives pertinent to geriatric patients encountered in those specialties. For example, in Neurology, the tool highlights the risks of long-term benzodiazepine use and inappropriate antipsychotics in dementia, while Endocrinology focuses on safer antidiabetic agents and thyroid management tailored for elderly patients (10).

7.2 Screening Parameters and Criteria

The GST comprises 14 to 16 key parameters per patient, categorized broadly into five lists:
• Potentially inappropriate medications independent of diagnosis,
• PIMs dependent on specific diagnoses,
• Potential prescribing omissions,
• Drug–drug interactions of clinical relevance,
• General care-related pharmacy items such as dose adjustments and monitoring requirements.
These parameters were selected after thorough literature review and expert consensus to encompass the most prevalent and clinically significant prescribing issues in Indian geriatrics (19).

7.3 Therapeutic Rationale and Alternatives

For each flagged medication or omission, the GST provides detailed therapeutic rationale, outlining risks associated with the drug in older adults, supported by evidence from Indian and global studies (2). Importantly, the tool suggests safe and effective alternatives, enabling prescribers and pharmacists to optimize therapy without compromising efficacy. For instance, sulfonylureas are flagged due to hypoglycemia risk, with DPP-4 inhibitors and SGLT2 inhibitors

recommended as alternatives in elderly diabetic patients, consistent with Indian diabetes guidelines (7).

In summary, the GST's development involved a comprehensive synthesis of international validated tools and Indian clinical insights to create a practical, department-specific screening instrument for improving geriatric prescribing safety.

APPLICATION AND IMPLEMENTATION

8.1 Screening Process and Flowchart

The implementation of the Geriatric Screening Tool (GST) involved a systematic screening process beginning with the identification of eligible patients aged 60 years and above attending both outpatient and inpatient departments. After obtaining informed consent, patients' demographic data, clinical diagnoses, and medication histories were collected. The GST was then applied to evaluate prescriptions against defined parameters such as potentially inappropriate medications (PIMs), potential prescribing omissions (PPOs), drug–drug interactions (DDIs), and care-related pharmacy items. The screening process was streamlined into a flowchart, which guided the steps from patient inclusion through detailed medication review to final data analysis and clinical intervention recommendations (19). This ensured consistency and reproducibility in applying the GST across departments.

8.2 Data Collection by Trained Pharmacists Data collection was carried out by clinical pharmacists trained specifically in geriatric pharmacotherapy and the use of GST 18). Pharmacists reviewed patients' medical records and prescriptions, recorded medication regimens, and flagged any issues based on GST criteria. Their expertise enabled accurate identification of inappropriate prescribing and omissions, as well as assessment of potential risks such as adverse drug reactions (ADRs) and drug interactions. The role of pharmacists was central to bridging gaps in clinical care, facilitating multidisciplinary communication, and ensuring that screening results translated into actionable clinical recommendations (13).

8.3 Decision-Making Supported by GST

The GST functioned as an evidence-based decision support tool, assisting pharmacists and clinicians in highlighting inappropriate drug use and recommending safer, effective alternatives tailored to elderly patients. For example, in cases where benzodiazepines were flagged for their fall risk, the GST suggested non-pharmacologic interventions or safer medications as per Indian guidelines (10). Moreover, the tool provided guidance on monitoring parameters and dose adjustments necessitated by age-related pharmacokinetic changes. This collaborative decision-making process improved prescribing appropriateness and patient safety, reinforcing the GST as an integral part of geriatric clinical workflows (17).

DATA ANALYSIS

9.1 Prevalence of PIMs, PPOs, and ADRs

The collected data from screening 870 geriatric patients were analyzed to determine the prevalence of potentially inappropriate medications (PIMs), potential prescribing omissions (PPOs), and adverse drug reactions (ADRs). Consistent with prior studies, a high prevalence of PIMs was observed, aligning with findings by (6), who reported similar rates in elderly populations internationally. The GST enabled identification of these prescribing issues systematically, facilitating targeted interventions. Additionally, PPOs were documented to highlight missed opportunities in essential drug therapies, which have been associated with suboptimal clinical outcomes (16). ADRs, both reported and predicted based on drug profiles, were assessed to quantify medication-related risks (20).

9.2 Frequency of Polypharmacy

Polypharmacy, defined as the concurrent use of five or more medications, was a significant finding in the dataset, echoing concerns raised by (14). The analysis explored the association between polypharmacy and the incidence of PIMs and ADRs, reinforcing the importance of comprehensive medication reviews. Quantifying the frequency of polypharmacy informed recommendations for deprescribing and safer prescribing practices within the geriatric cohort.

9.3 Department-wise Breakdown of Findings

A detailed department-wise analysis was conducted to identify patterns in inappropriate prescribing and omissions across clinical specialties such as Neurology, Endocrinology, Cardiology, and Orthopedics. This stratification enabled the GST to target specific therapeutic challenges unique to each department, consistent with (10), who emphasized the value of specialty-specific interventions in geriatric pharmacotherapy. Such granular analysis also aided in resource allocation and prioritized pharmacist interventions where the risk was highest.

9.4 Statistical Tools for Significance Testing

Statistical analyses were performed using SPSS software (version XX) to evaluate the significance of associations between PIM prevalence, polypharmacy, and clinical outcomes. Descriptive statistics summarized frequencies and percentages, while inferential tests such as Chi-square and logistic regression assessed relationships between variables. Significance was set at $p < 0.05$, following established analytical standards in clinical pharmacology research (4).

9.5 Indicators of Outcome: Reduction in PIMs, Improved Drug Appropriateness, and Cost Analysis

Post-intervention data were analyzed to measure indicators including reduction in PIMs, improvement in

prescription appropriateness, and cost savings due to medication optimization. These outcomes are consistent with reports (14), who demonstrated that pharmacist-led medication reviews result in improved clinical and economic outcomes. The GST thus provided a measurable framework to enhance prescribing quality and reduce unnecessary healthcare expenditures.

RESULTS

10.1 Patients with At Least One Potentially Inappropriate Medication (PIM)

Among the 870 geriatric patients screened using the GST, 540 patients (62%) were identified as having at least one potentially inappropriate medication (PIM) in their prescription. This high prevalence aligns with earlier findings reported by (6), which documented that more than half of elderly patients in clinical settings are prescribed one or more PIMs, contributing to increased risk of adverse outcomes.

10.2 Top 10 Most Common Inappropriate Prescriptions

The GST screening revealed the top ten most frequently prescribed inappropriate medications. These included benzodiazepines such as diazepam, sulfonylureas like glyburide, and tricyclic antidepressants such as amitriptyline. Other common PIMs were long-term proton pump inhibitors (PPIs) and nonsteroidal anti-inflammatory drugs (NSAIDs) prescribed without gastro protection. These results mirror the patterns found in Indian geriatric populations (8), emphasizing the need for targeted deprescribing strategies.

10.3 Most Affected Departments

The departments with the highest incidence of PIMs and prescribing omissions were Neurology, Endocrinology, and Cardiology, accounting collectively for over 60% of flagged prescriptions. Neurology frequently flagged benzodiazepine and antipsychotic misuse, while endocrinology identified hypoglycaemia risks due to sulfonylureas. These department-specific patterns support the observations (10), who highlighted specialty-focused prescribing challenges in elderly care.

10.4 Medication Modifications Post-GST Screening

Following GST-led pharmacist interventions, approximately 320 patients (37%) had their medication regimens modified. Changes included discontinuation or substitution of PIMs, initiation of omitted essential drugs, and adjustment of dosages to safer alternatives. The acceptance rate by physicians for these recommendations was high, exceeding 85%, consistent with similar studies showing collaborative pharmacist-physician engagement improves medication safety (13).

10.5 Adherence Improvements and Follow-up Outcomes

In subsequent follow-ups conducted over a 6-month period, patients whose prescriptions were optimized using GST demonstrated significant improvements in medication adherence and experienced fewer adverse drug events (ADRs). These improvements translated into reduced hospital readmissions and enhanced quality of life measures, echoing the benefits documented in pharmacist-led medication review programs globally (14).

DISCUSSION

11.1 Comparison with Literature from Belgium, EU, and India

The findings of this study align closely with international research, particularly studies from Belgium and the broader European Union, where the GheOP³S tool has been effectively utilized to identify potentially inappropriate medications (PIMs) among older adults (21; Wauters et al., 2017). Similar to these studies, the prevalence of PIMs and polypharmacy in our Indian cohort was substantial, emphasizing that inappropriate prescribing remains a global challenge in geriatric care. However, the unique prescribing patterns and therapeutic options available in India necessitated specific adaptations to the GST tool, underscoring the importance of localized modifications for clinical relevance (17). Furthermore, Indian studies by Kaur et al. (2020) and Sharma & Mishra (2022) corroborate the high burden of inappropriate medication use, validating the necessity of such tools within the country.

11.2 Role of Pharmacists and Interdisciplinary Teams

The study reaffirmed the critical role clinical pharmacists' play in optimizing medication regimens for elderly patients. Pharmacist-led interventions, supported by the GST, facilitated identification and resolution of drug-related problems, consistent with outcomes reported (14; 13). Collaborative efforts among pharmacists, physicians, and nursing staff fostered a multidisciplinary approach that enhanced clinical decision-making, improved patient safety, and increased prescriber acceptance of recommendations (18). This teamwork is particularly vital in geriatric care, where complex comorbidities demand nuanced and individualized therapeutic strategies.

11.3 Challenges in Tool Implementation in Real-World Hospital Settings

Despite the demonstrated benefits, implementing the GST tool in routine hospital practice presented several challenges. Time constraints and heavy patient loads in tertiary care centers limited the opportunity for comprehensive medication reviews (22). Additionally, variability in electronic health record (EHR) systems and incomplete patient data hindered seamless application of the tool. Resistance from some prescribers due to unfamiliarity with the tool or skepticism about pharmacist recommendations was observed, echoing findings from other resource-constrained settings (11). Training and sensitization of healthcare professionals were essential components in overcoming these barriers.

11.4 Scope for Scalability across Indian Hospitals

The GST tool's adaptability and positive impact suggest strong potential for wider adoption across Indian hospitals. Its department-wise structure facilitates customization according to institutional needs and local prescribing practices. Incorporating GST into electronic prescribing systems could streamline its application and enhance real-time decision support (19). Moreover, expanding pharmacist-led medication review services and promoting interdisciplinary collaboration at a national level could significantly improve medication safety for India's rapidly growing elderly population. Future multicenter studies and pilot programs are warranted to evaluate scalability and cost-effectiveness across diverse healthcare settings (17).

CONCLUSION

The present study demonstrates that the Geriatric Screening Tool (GST), adapted from internationally validated tools and tailored for the Indian clinical environment, is both feasible and effective for routine use in tertiary care hospitals. Its application resulted in the identification and reduction of potentially inappropriate medications (PIMs), correction of prescribing omissions, and overall improvement in rational drug use among geriatric patients. These outcomes substantiate the GST's value in enhancing medication safety and optimizing pharmacotherapy in elderly populations within Indian healthcare settings (17; 19).

Furthermore, the study highlights the important role of clinical pharmacists and interdisciplinary teams in implementing such screening tools, emphasizing collaborative approaches for improved patient outcomes (14). Given the high prevalence of polypharmacy and associated risks in elderly patients, the GST offers a pragmatic solution to minimize adverse drug events and improve therapeutic efficacy.

In light of these findings, it is recommended that hospital formularies and clinical protocols incorporate GST-based screening as a standard practice for geriatric care. Integration of the GST into electronic health record systems and wider adoption across Indian healthcare institutions can significantly advance safe prescribing practices and contribute to policy frameworks aimed at improving elderly patient care at a national scale.

FUTURE DIRECTIONS

To maximize the impact of the Geriatric Screening Tool (GST) in enhancing medication safety for elderly patients across India, several future initiatives are recommended. Foremost is the digitization of the GST, enabling seamless integration into Electronic Medical Record (EMR) systems. Digital tools can facilitate real-time alerts for potentially inappropriate prescriptions and omissions, thereby supporting prescribers and pharmacists in making timely, evidence-based decisions (17). Integration within EMRs would also enable automated data collection and analysis for continuous quality improvement.

Further, state-wise adoption and validation studies are essential to ensure the GST's applicability across diverse healthcare infrastructures and population demographics in India. Regional variations in disease prevalence, healthcare access, and prescribing patterns necessitate localized validation and customization to optimize the tool's sensitivity and specificity (19).

Moreover, expanding the scope of GST use beyond tertiary hospitals to community pharmacies and nursing homes could significantly enhance geriatric care in outpatient and long-term care settings. Given the increasing elderly population receiving care in such environments, pharmacist-led medication reviews supported by GST can play a critical role in early detection of medication-related problems and prevention of adverse drug events (14). This broader application promises to improve continuity of care and medication safety for elderly patients throughout the healthcare continuum.

CONFLICT OF INTEREST:

The authors have no conflicts of interest regarding this investigation.

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