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# Review: Utilization of Decision Support System in Identification of Drug-related Problems in Geriatric Patients

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ABSTRACT

**Background:** Globally, there were 703 million people aged 65 years or older in 2019. The largest population were in East and Southeast Asia (260 million) followed by Europe and North America (more than 200 million). This number is expected to grow to over 1.5 billion people by 2050. Treatment-related problems are events associated with drug use that may affect the patient's therapeutic goals. The prevalence of treatment-related problems is estimated to be 45.1% in populations meeting criteria for advanced age, polypharmacy, and multimorbidity. A decision support system (DSS) is developed based on individual conditions to provide recommendations for therapeutic and dosage selection, and to prevent drug interactions in complex cases. This study aims to evaluate the use of DSS in identifying treatment-related problems in geriatric patients across various countries. **Method:** This study uses a narrative review method to systematically discuss previous research findings. **Results:** This review examined journals on the use of decision support systems in identifying drug-related problems in geriatric patients. A search article published between 2016-2021 in the PubMed database yielded 10 relevant articles. DSS tools have shown to improve the continuity of care for geriatric patients. Previous DSS tools used include AGAlink, G-MEDSS, PRIMA-eDS, STRIPA, SENATOR, and TRIM. **Conclusion:** DSS represents a significant technological advancement that can be applied to prevent and reduce inaccuracies in prescribing, particularly for geriatric patients.



## Introduction

Globally, there were 703 million people aged 65 years or older in 2019, with most of this population located in East and Southeast Asia (260 million), followed by Europe and North America (more than 200 million). This number is expected to increase to over 1.5 billion by 2050, with the largest growth projected in East and Southeast Asia, reaching 573 million by 2050 [1]. In Indonesia, the elderly population in 2019 was 25.64 million, with a majority being female (52.35%). The provinces with the highest percentages of elderly people are Yogyakarta Special Region

(14.50%), Central Java (13.36%), East Java (12.96%), Bali (11.30%), and North Sulawesi (11.15%) [2].

Elderly individuals are more susceptible to various chronic conditions and illnesses, such as cardiovascular disease (CVD), diabetes mellitus (DM), hyperlipidemia (HLP), hypertension (HT), chronic obstructive pulmonary disease (COPD), anemia, chronic kidney disease (CKD), and cancer. These health complications lead to a higher need for concurrent medication use. The use of multiple medications for acute medical conditions increases the risk of drug-related problems [3]. Additionally, elderly individuals are prone to drug-related problems (DRPs) due to age-associated alterations in pharmacokinetics and pharmacodynamics, as well as cognitive deterioration and functional decline [4]. The deterioration of organ function with aging, combined with challenges unique to this patient group (such as heightened sensitivity to side effects and medication nonadherence) likely leads to a higher risk of hospitalization [5].

Treatment-related problems are events associated with drug use that may impact a patient's therapeutic goals [6]. The prevalence of medication-related problems has been found to be 45.1% among populations characterized by advanced age, polypharmacy, and multimorbidity [7]. A study by Sell et al. (2019) reviewed 1,090 treatments, finding that 84.2% (n = 918) of these cases involved identifiable treatment-related problems [8]. In Malaysia, a study on geriatric patients found that 49.5% experienced polypharmacy, 28.9% had potentially unnecessary treatments, 60.6% had compliance issues, and 39.3% were at risk of drug-induced falls [9]. In addition to the presence of multiple comorbidities and polypharmacy, the physical conditions associated with aging also influence the incidence of treatment-related problems [10,11].

DSS have been developed to support rational therapy for patients by providing personalized recommendations for therapy and dose selection, as well as preventing drug interactions in complex conditions [12]. DSS is typically integrated with Electronic Health Records (EHR), a feature common in modern healthcare services, and often part of the electronic prescribing function. The implementation of DSS is part of broader efforts to enhance patient safety and improve the quality of care [13]. To date, no reviews have focused specifically on the use of DSS to identify medication-related problems in geriatric patients. However, some review studies have examined the use of DSS to improve healthcare services. For example, Yourman et al. (2008) demonstrated a modest improvement in prescribing practices for geriatric patients using DSS, measured by reductions in the use of inappropriate drugs, optimized dosing, and improved drug selection [14]. Another review highlighted the use of DSS to enhance medication safety for long-term care patients at home, showing benefits, effectiveness, and potential to improve drug safety for patients in home care settings [15]. DSS interventions have also been shown to improve care for geriatric patients in hospital settings [16]. This study aims to examine the use of DSS in identifying medication-related problems in geriatric patients across various countries. This study provides new insights into the utilization of DSS in identifying DRPs in geriatric patients, highlighting its role in improving medication safety and optimizing pharmacotherapy. The findings emphasize the potential of DSS in addressing polypharmacy risks, age-related pharmacokinetic changes, and medication adherence challenges. The knowledge gained can guide future research in enhancing AI-driven DSS, expanding its applications beyond DRP identification to comprehensive geriatric assessments, chronic disease management, and rehabilitation planning, ultimately improving patient outcomes and healthcare quality.

## Materials and Method

The method used in this research is a literature study or narrative review. This study examines journals related to the utilization of decision support systems in identifying drug-related problems in geriatric patients. A search limited to publications from 2016 to 2021 yielded 10 articles from the PubMed database, selected based on inclusion and exclusion criteria. The articles selected from the 2016-2021 period were chosen because they reflect the latest developments in the utilization of Decision Support Systems (DSS) for identifying Drug-Related Problems (DRPs) in geriatric patients. During this period, significant advancements in DSS technology have enhanced the effectiveness of these systems in clinical practice. Additionally, articles from this timeframe

are more aligned with the latest healthcare standards and policies, ensuring data accuracy and relevance to current patient conditions and healthcare services. The inclusion criteria are detailed in Table 1, while articles classified as reports, books, reviews, conference articles, or presentations were excluded.

**Table 1.** Inclusion and Exclusion Criteria

| | Inclusion Criteria | Exclusion Criteria |
|---|---|---|
| **Population** | Geriatric patients | General population |
| **Intervention** | Implementation of DSS for identifying DRPs | - |
| **Comparator** | General practice | - |
| **Outcome** | Outcome of DRP identification (components) | Articles that do not specify an outcome |
| **Language** | English | Non-English |
| **Study Design** | Prospective or retrospective observational studies and quantitative research results | Qualitative research |

## Results

Based on this literature review, several countries across different continents have implemented DSS, including Australia [17], Austria [18,19], the Netherlands [20,21], Belgium [20,22], Germany [18,19], Iceland [22], Ireland [20,22], Italy [18,19,22], Scotland [22], Spain [22,23], Switzerland [20,24], the United Kingdom, and the USA [25]. The systems primarily employ the STOPP (Screening Tool of Older Person's Prescriptions) and START (Screening Tool to Alert doctors to Right Treatment) criteria, which facilitate the review of drug use in geriatric patients with multimorbidity. These criteria are designed to identify common issues in geriatric care, with STOPP criteria focusing on Potentially Inappropriate Medications (PIMs) and START criteria highlighting Potential Prescribing Omissions (PPOs) [26,27].

## Discussion

### Decision Support System in Healthcare

Many have proposed a DSS as a crucial solution for enhancing patient safety, alongside physician-based computerized order entry. This technology could play a significant role in managing chronic diseases, where healthcare costs are substantial and self-efficacy influences health outcomes. However, the effectiveness of DSS depends on factors such as technology, proper training, and continuous support [28]. The artificial intelligence clinical decision support system is an advanced tool aimed at assisting healthcare professionals in making well-informed, evidence-based decisions for patient care. By utilizing artificial intelligence algorithms and data analysis techniques, it delivers personalized recommendations and valuable insights. This system encompasses various features and benefits, including patient data analysis, diagnostic and treatment guidance, drug interaction and adverse event detection, predictive analytics, real-time monitoring with alerts, and continuous learning for ongoing improvement [29]. A review of different DSS models, along with an analysis of the components that enhance system performance, assists clinicians in selecting the most suitable system for their practice. This helps achieve key benefits, such as minimizing medical and medication errors, ensuring adherence to standard treatment and medication guidelines, reducing costs, and ultimately enhancing healthcare quality. Overall, improvements can be observed in three key areas: patient safety and quality of care, cost efficiency, and the provider's level of knowledge [30]. DSS provides several key benefits, including enhancing the quality of inpatient care, supporting evidence-based clinical and therapeutic decision-making, enabling personalized treatment, and improving the efficiency and productivity of the healthcare system. However, its implementation comes with challenges, such as the need for physicians to adapt to the system and software, as well as the requirement for continuous updates and technical support [31].

**Table 2.** Research related to the Utilisation of Decision Support System in Identifying Problems related to Drug Use in Geriatric Patients

| Author | Year | Country | Location | DSS | Intervention |
|---|---|---|---|---|---|
| Avalos-Mejia et al. [32] | 2021 | Australia | Family Doctor Practice | AGAlink | The system provides recommendations to address prescribing inaccuracies and potential drug interactions. |
| O'Donnell et al. [17] | 2020 | Australia | Community | G-MEDSS | The system consists of three main features: identifying therapeutic targets and treatment strategies, detecting anticholinergic use and sedative effects, and providing information on potential patient outcomes and risks associated with geriatric medication use. Additionally, it explores patient behaviors, beliefs, and experiences related to the number of medications taken and their responses to discontinuing one or more medications. |
| Rieckert et al. [18] | 2020 | Austria, Italy, Germany, United Kingdom | Hospital | PRIMA-eDS | The system will assess the treatment of geriatric patients with polypharmacy, analyzing prescription accuracy using diagnostic data, vital signs, and laboratory results. It will provide recommendations for prescription adjustments based on the best available evidence, including dose modifications for renal impairment, potential drug interactions, contraindications, and side effects. |
| Jungo et al. [24] | 2019 | Switzerland | Primary Care | STRIPA | Patient data will be inputted from the FIRE database (Family Medicine ICPC Research using Electronic Medical Records) into the STRIPA software. This data includes patient characteristics, vital signs, laboratory results, signs and symptoms, and diagnosis codes. The general practitioner (GP) will log in to STRIPA to ensure that all data is complete. STRIPA will then provide recommendations regarding under prescribing, ineffective prescribing, overprescribing, side effects, contraindications, drug-drug and drug-disease interactions, incorrect dosages or dosing frequencies, and practical intake issues. The GP can choose to follow, partially follow, or reject these recommendations. |
| Boersma et al [21] | 2019 | Netherland | Hospital | STRIPA | The system will provide prescribing recommendations for geriatric pre-operative patients based on inputted data, including drug use, age, gender, medication history, blood pressure, pulse, and Glomerular Filtration Rate (GFR) values. These recommendations will focus on identifying Potential Prescribing Omissions (PPOs), Potentially Inappropriate Medications (PIMs), and optimal dosing. |
| Adam et al. [20] | 2019 | Netherland, Belgium, Ireland, Switzerland | Hospital | STRIPA | The system will assist in analyzing the patient's treatment by predicting drug side effects and providing safe, appropriate treatment |

| Author | Year | Country | Location | DSS | Intervention |
|---|---|---|---|---|---|
| | | | | | recommendations based on STOPP/START criteria. It will also monitor interactions and offer dose recommendations tailored to renal function. |
| Lavan et al. [22] | 2019 | Belgium, Iceland, Ireland, Italy, Scotland, Spain | Hospital | SENATOR | The system aims to optimize prescribing for geriatric patients using STOPP and START criteria, identify drug-drug and drug-disease interactions, and recommend non-pharmacological treatments to prevent delirium. |
| Fried et al. [25] | 2018 | USA | Primary Care | TRIM | The system will retrieve medication and chronic condition data from Electronic Health Records (EHR) and additional information from telephone patient assessments. It will use algorithms to analyze treatment discrepancies, identifying inappropriate prescribing and potentially unnecessary treatment regimens. |
| Vélez-Díaz-Pallarés et al. [23] | 2017 | Spain | Hospital | CPOE-CDSS | The fully implemented Computerized Physician Order Entry (CPOE) system includes an automatic alert for STOPP-START criteria, which is commonly used in Europe to prevent potentially unnecessary prescribing. Based on the patient data, the DSS displays potential errors in the patient's treatment. |
| Sonnichsen et al. [19] | 2016 | Austria, Italy, Germany, United Kingdom | Primary Care | PRIMA-eDS | The system will analyze the patient's diagnosis, medication, symptoms, vital signs, and laboratory results to provide recommendations for drug discontinuation or treatment modification. |

**Decision Support System intervention in geriatric patients**

Geriatric patients represent a population that requires special attention, particularly regarding medication prescriptions. These patients are more likely to have two or more chronic diseases simultaneously (multi-morbidity), which is associated with an increased risk of death, decreased quality of life, and higher rates of hospitalization. Multi-morbidity in geriatric patients often leads to polypharmacy, where individuals receive complex treatment involving more than five medications. Polypharmacy carries several risks, including treatment-related problems, duplication of therapy, unnecessary drug prescriptions, adverse drug reactions (ADRs), drug interactions, low compliance, and increased treatment costs [33]. This context highlights the need for a DSS to identify and provide prescribing recommendations tailored for geriatric patients.

Research conducted by Avalos-Mejia et al. [32] involved 31 family doctors and their responses to the use of AGAlink (Asynchronous Geriatric Program), a web-based system designed for geriatric patients. This system can detect prescribing inaccuracies and potential drug interactions. G-MEDSS (Goal-Directed Medication Review Electronic Decision Support System), developed by O'Donnell et al. G-MEDSS, targets geriatric patients in the community who are at risk of polypharmacy and adverse drug events [17]. It specifically addresses patients using anticholinergic and sedative medications within the framework of the Home Medicines Review (HMR) program, which is a collaborative effort among general practitioners, pharmacists, and patients. G-MEDSS features three main components: the Goals of Care Management Tool, the Drug Burden Index (DBI) Calculator©, and the revised Patients' Attitudes towards Deprescribing (rPATD) questionnaire.

Research conducted by Rieckert et al. [19] developed a system known as PRIMA-eDS (Polypharmacy in Chronic Disease - Reduction of Inappropriate Medication and Adverse Drug Events in Older Populations). This system was tested in several countries, including Austria, Italy, Germany, and the United Kingdom, and is designed to identify potential prescribing inaccuracies. PRIMA-eDS assists clinicians in making informed prescribing decisions based on individual patient data and the best available evidence. The trial was conducted in primary care settings, including community and nursing homes, and involved patients aged over 75 who were prescribed more than eight medications. The intervention aimed to provide recommendations for modifying or discontinuing prescriptions in geriatric patients [19].

Jungo et al. [24] developed a system known as STRIPA (Systematic Tool to Reduce Inappropriate Prescribing Assistant). This system has been tested through several programs, including Optimizing Pharmacotherapy in the Multimorbid Elderly in Primary Care (OPTICA) and Optimizing Therapy to Prevent Avoidable Hospital Admissions in Multimorbid Older People (OPERAM). Both programs were implemented in primary care and hospital settings. In the OPTICA program, clinicians in 40 primary care settings used STRIPA as an intervention to review medication use in geriatric patients. The OPERAM program was conducted with hospitalized patients, where prescribing physicians were divided into clusters. Geriatric patients with multi-morbidity and polypharmacy received either a medication review or usual care, depending on their cluster. Patients were followed up by phone at 2, 6, and 12 months post-intervention [20]. Additionally, another study focused on outpatient geriatric patients to assess changes in prescriptions due to Potential Prescribing Omissions (PPOs), Potentially Inappropriate Medications (PIMs), and inappropriate dosing based on STRIPA recommendations [21].

SENATOR (Software Engine for the Assessment and Optimization of Drug and Non-Drug Therapy in Older Persons), developed by Lavan [22], was tested using the Prospective Randomized Open-label, Blinded Endpoint (PROBE) controlled trial method. The study involved patients with acute illnesses who were screened 48 hours after hospital admission. Data collected included the patient's medical history, current medications, laboratory results, ECG readings, and cognitive and functional status. The system generates reports based on the inputted data, providing recommendations to modify or discontinue current treatments, initiate new therapies, identify drug interactions, and suggest non-pharmacological interventions. The study included 900 patients in the control group and 900 patients in the intervention group. Subjects were monitored for 14 days post-intervention to assess the incidence of preventable or resolvable adverse drug events.

Another system aimed at reducing the incidence of inappropriate prescribing is TRIM (Tool to Reduce Inappropriate Medications). The study involved 128 veterans aged 65 years or older who were prescribed seven or more medications. This system is integrated with Electronic Health Records (EHR), initially extracting patient data and medication information. It then generates medication reconciliations, recommendations for discontinuation or dose adjustments, and tailored suggestions based on patient needs related to adherence and social support.

The utilization of technology was also demonstrated in a study conducted by Vélez-Díaz-Pallarés et al. [23], which involved a Computerized Provider Order Entry (CPOE) system that had been successfully implemented in a hospital six years prior. This system employs STOPP/START criteria to identify inappropriate drug prescribing. A six-month observation was carried out in a 947-bed tertiary care hospital, focusing on patients aged over 65 who were hospitalized for 48 hours or more and receiving more than three medications for chronic conditions. The trial aimed to assess whether the combined CPOE-CDSS system could prevent erroneous prescribing in geriatric patients. Some of the alerts generated by the system included warnings about drug interactions (e.g., meropenem and valproic acid), maximum dosage limits (e.g., acetaminophen 4 grams), and therapy duplication (e.g., tiotropium and ipratropium bromide). A summary of previous research related to the use of DSS in identifying drug-related problems in geriatric patients, including the year, country, location, DSS used, and interventions carried out, can be found in Table 2.

**Outcome of Decision Support System Usage**

The results of the AGAlink intervention provided to family doctors indicated that 90% of the physicians utilized the system without the need for direct supervision. The system is considered beneficial as it provides relevant information and supports effective therapy prescribing for patients. However, a significant barrier remains in the form of technological proficiency, particularly among senior doctors [32]. In a separate study, G-MEDSS, utilized through the Home Medicines Review (HMR) program, demonstrated a reduction in the Drug Burden Index (DBI) after three months of intervention. Additionally, there were notable clinical improvements in functional status, fall risk, general practitioner visits, medication adherence, and mortality rates following the three-month period [17].

The PRIMA-eDS trial involved 181 doctors and 1,953 participants in the intervention group, while the control group comprised 178 doctors and 1,951 participants. The primary outcome of unplanned re-hospitalization or death occurred in 871 participants from the intervention group and 944 participants from the control group. The results indicated no significant difference between the groups regarding the primary outcome. However, a reduction in medication use was achieved without causing harm to patients [18].

Research involving the STRIPA intervention demonstrated that prescribing recommendations can enhance the accuracy of prescriptions in geriatric patients. The subjects in the intervention group exhibited significant changes in prescribing practices due to the identification of Potential Prescribing Omissions (PPO) and Potentially Inappropriate Medications (PIM). However, no significant difference was observed in the dosing regimen [21].

The SENATOR trial is complex and presents several challenges. A key factor in its success is the implementation of the system's recommendations by the participating physicians. Additionally, it is crucial to document any adverse drug events that occur during the trial. However, responses from doctors to the recommendations have been notably varied [22]. In the TRIM intervention, the subjects demonstrated a higher Patient Assessment of Care for Chronic Conditions (PACIC) score (29.7%) compared to the control group (15.6%), although this difference was not statistically significant. Nevertheless, the TRIM system effectively improved communication regarding treatment and enhanced documentation accuracy [25]. Moreover, the integration of the Computerized Provider Order Entry (CPOE) system with DSS revealed that 107 out of 117 patients had their prescribing errors prevented. This improvement may enhance patient safety implementation in hospitals.

This study provides valuable insights into the use of DSS for identifying DRPs in geriatric patients, highlighting its role in improving medication safety and managing polypharmacy risks. It also identifies key challenges such as interoperability issues, user adoption barriers, and the need for continuous improvements. However, the study is limited by its focus on DRP identification, lacking discussion on broader geriatric care aspects like chronic disease management. Additionally, its findings may not be universally applicable due to variations in healthcare systems and technology adoption. Moreover, the limitation of this review is that it primarily focuses on the utilization DSS in identifying DRPs in geriatric patients, without extensively covering other aspects of geriatric care, such as disease management and rehabilitation. While identifying and managing DRPs is crucial in geriatric populations due to their high medication burden and susceptibility to adverse drug events, comprehensive geriatric care extends beyond medication management. It also involves disease management strategies, preventive care, and rehabilitation services, all of which play a critical role in enhancing overall health outcomes and improving the quality of life for elderly patients. However, this review does not explore how DSS could contribute to these broader aspects of geriatric care, potentially limiting the full understanding of its role in holistic patient management. Future research should explore the integration of DSS applications beyond medication-related functions, including chronic disease monitoring, fall prevention strategies, cognitive impairment assessment, and rehabilitation planning. This broader approach would help optimize geriatric care by addressing multiple health challenges faced by aging populations.

## Conclusion

Geriatric patients represent a population that requires special attention due to the prevalence of multi-morbidity and polypharmacy. Decision Support Systems (DSS) are technological advancements that can help prevent and reduce the incidence of inaccurate prescribing. To achieve optimal treatment outcomes for geriatric patients, collaboration among pharmacists, doctors, nurses, and other healthcare professionals is essential. This teamwork is crucial for meeting treatment goals, preventing complications, and reducing mortality.

## Declaration

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**Conflicts of Interest:** The authors declare that there is no conflict of interest in the preparation of this article.

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