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Review Article

Drug Related Problems in Geriatric Critical Care: Challenges, Clinical Implications and Future

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ABSTRACT

Drug Related Problems (DRP) represent a significant and often under-recognised challenge in the care of elderly patients admitted to Intensive Care Units (ICU). Epidemiological data reveal a high prevalence of DRP among geriatric ICU patients, with trends dominated by polypharmacy, inappropriate medication use, drug-drug interactions, and adverse drug reactions. Patient-related factors such as multimorbidity, organ dysfunction, and the complexity of critical care regimens contribute to the development of DRP. Furthermore, high-risk drug classes-including sedatives, analgesics, antibiotics, anticoagulants, and cardiovascular agents-pose significant risks. Communication gaps, inadequate medication reconciliation, limited geriatric-focused therapy, and the rapid pace of ICU decision-making further complicate DRP management. DRP in elderly ICU patients are strongly associated with increased morbidity, prolonged hospitalisation, higher healthcare costs, and mortality. Evidence-based strategies, including medication review, clinical decision support systems, deprescribing, therapeutic drug monitoring, and multidisciplinary care models, have demonstrated effectiveness in reducing DRP. Pharmacists can play a crucial role by assisting with medication reconciliation, identifying risks, optimising therapy, and supporting clinicians through real-time interventions. This review highlights the importance of standardised DRP monitoring tools, enhanced pharmacist involvement, and future research focused on predictive analytics and personalised pharmacotherapy in geriatric critical care settings. Based on this aim, we collected and evaluated nearly 70 articles from various databases (using specific keywords) that were included in this review.

Keywords: Drug related Problems, Geriatric Critical Care, Clinical Implications, Clinical Pharmacist and Artificial Intelligence.

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INTRODUCTION

Globally, over the past decade, there has been a significant demographic shift towards the older population (WHO, 2018). The population of individuals aged 60 and older is on track to hit the 2 billion mark by 2050. Beyond physical changes, ageing is most often associated with a gradual decrease in mental capacity, a growing risk of diseases, associated comorbidities, and ultimately death (WHO, 2022). The need for multiple medications to treat diseases in older adults is a point of concern, as older adults metabolise medications differently, and this may exacerbate Drug Related Problems (DRP) as well as drug related hospital admissions (Maher *et al*., 2014). DRP are particularly more common in general settings and often life-threatening in the Intensive Care Unit (ICU). Dose and drug selection problems, long-term usage of multiple medications (polypharmacy), Adverse Drug Event (ADE)/Adverse Drug Reaction (ADR), Drug-Drug Interactions (DDI) etc, are some common DRP in ICU settings (Cakir *et al*., 2024).

According to the Pharmaceutical Care Network Europe Association (PCNE), DRP is defined as "an event or circumstance involving drug therapy that actually or potentially interferes with desired health outcomes." (VanMil (n.d)) Certain conditions like DDI, inappropriate use, poor monitoring, adverse effects, and variability of pharmacology knowledge across healthcare professionals could be related to DRP. However, there is controversy on the impact of these variables over others, such as gender, age, and social factors, on the risk of developing DRP (Freyer *et al*., 2018; Ferrández *et al*., 2018). Altered pharmacokinetics and pharmacodynamics, polypharmacy, poor adherence, hospital readmissions, and cognitive decline are the most notable variables for the geriatric population to be at higher risk for DRP. Although a significant number of DRP are avoidable (Bekele *et al*., 2021), their occurrence is linked to increased rates of illness, death, and

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medical costs, ultimately diminishing a patient's overall quality of life (Ahmad *et al.*, 2014), In the last decade, several strategies have failed in attempts to improve elderly patient well-being and reduce healthcare costs, accounting for 15%-30% of all drug related hospital admissions. A more comprehensive approach is thus needed to clear the issues that increase the risk of ADE, DDI, etc, contributing to DRP (Greiver *et al.*, 2019). This review on DRP in critically ill older patients is a present need.

Objectives Of The Review

This narrative review aims to summarise the extent of Drug-Related Problems (DRPs) in elderly patients admitted to critical care units, with a focus on causes, challenges and clinical implications.

METHODOLOGY

Literature search strategy

To identify relevant research on DRP among elderly patients in intensive care settings, a narrative literature review was conducted. Predefined keywords such as "drug-related problems," "adverse drug reactions," "medication errors," "geriatric inpatients," "critical care," and "pharmacist interventions" were used to search electronic databases, including PubMed/MEDLINE, Scopus, Web of Science, and Google Scholar. The literature search included articles published between 2004 to 2025. DRP in hospitalised geriatric populations (aged ≥65 years) were selected; special consideration was given to ICU settings. Original research articles, observational studies, interventional studies, and relevant review articles were all taken. Approximately 70 eligible articles were collected and reviewed. Data extraction was done, and results were narratively described to explain patterns and trends in DRPs, their clinical consequences, and the effects of pharmacist-led treatments.

Epidemiological Findings

Australia reports the highest rate at 22.94%, followed by the USA (18.76%) and Europe (12.34%). Although Asian countries show a slightly lower overall incidence of 12.15%, the problem remains substantial (Hadia *et al.*, 2022). Older adults aged 65 years and above are at risk for DDI due to polypharmacy. When these interactions become clinically significant, they may lead to adverse drug reactions, longer hospital stays, and an increased chance of death (Prakash *et al.*, 2025). Among community-dwelling older adults, potential prescribing omissions are common, affecting nearly 58.6% of participants (Hanna *et al.*, 2022). Trends also show that potential Drug Duplication (DD) has risen over the years, from 5.2% to 10.6% among those aged 65-79 and from 7.0% to 11.7% in individuals aged 80 and above. The medications most often involved in duplication were β-blockers, Angiotensin Converting Enzyme inhibitors, and calcium channel blockers in 2006. By 2021, vitamin B12, folic acid, β-blockers, and angiotensin II receptor blockers had become more common (Hanna *et al.*, 2022; Erhan *et al.*, 2024). Together, these findings point to the need for change in prescribing practices, particularly in vulnerable geriatric groups. Ageing also brings a gradual decline in homeostatic reserve, which varies widely from one person to the next and is further complicated by age-related changes in pharmacokinetics (Ngcobo, 2025).

CAUSES AND RISK FACTORS

Patient related Factors Role in Drug related Problems

Altered pharmacokinetic profiles due to impaired renal and hepatic clearance represent the most significant modifiable risk factors for DRP in older adults. Research also shows that prescribing drugs (renally cleared) at doses meant for younger adults is a direct cause for DRP, as the clearance of "flow-limited" drugs (those with high first-pass metabolism) is expected to decrease by 40-60% in the elderly compared to young individuals (Cohen *et al.*, 2024). Estimating Creatinine Clearance (CrCl) alone is crucial, as in the elderly, reduced muscle mass leads to false interpretations. One study found that in elderly subjects (mean age 70), the drug's Area Under the Curve (AUC), a measure of total drug exposure, was approximately twice as high as in young subjects, and the half-life was longer due to reduced clearance (Garinc *et al.*, 2021). This demonstrates a clear need for dose adjustments in older patients, as CrCl below 50 mL/min has a higher risk of DRP (Khananthai *et al.*, 2024). Toxicity risk increases in drugs with high hepatic extraction ratios, decreased liver blood flow and decreased enzyme activity (Kamimura *et al.*, 2019). Research supports the need for advanced clinical intervention by clinical pharmacists and implementing criteria (such as Beers or STOPP/START) helps to manage the DRP (Zhu *et al.*, 2023).

Other Patient related Factors

Body Mass Index

Body Mass Index (BMI) alters pharmacokinetics, influencing drug accumulation (prolonged elimination half-life), and increasing the risk of toxicity. The inadequacy of BMI as a clinical indicator stems from its failure to account for muscle mass depletion, which is a primary driver of altered ADME (Absorption, Distribution, Metabolism and Excretion) parameters and subsequent drug-related problems in the geriatric population (Barras and Legg, 2017).

Gender

Gender-based variations in gastric emptying, total body water, and muscle mass, along WITH differences in sex hormones and Glomerular Filtration Rate (GFR), significantly alter the pharmacokinetic profiles of elderly patients. Women experience ADR (due to biological and physiological differences) nearly

twice as much as men and are more likely to be hospitalised as a result (Zucker and Prendergast, 2020).

Drug related Factors Role in Drug related Problems

The most common DRP associated with Narrow Therapeutic Index (NTI) drugs are non-optimal dose and DDI, pointing to the need for Therapeutic Drug Monitoring (TDM) (Dasgupta, 2024). A study found that NTI drugs were significantly more often associated with DRP (40% of the times they were used) than non-NTI drugs (19%) (Blix *et al.*, 2010). Current studies highlight the heightened risk of DDIs and pharmacological complexity in older adults, emphasising their status as a high-risk population (Varghese *et al.*, 2024). Current research studies are focusing on the effectiveness of incorporating Clinical Decision Support Systems into electronic health records to provide real-time alerts on NTI-DDI, inappropriate dosing, and Potentially Inappropriate Medication (PIM) use in the elderly (Ng *et al.*, 2025). Studies show NTI drugs have a significantly higher risk ratio for DRP compared to non-NTI drugs (Shaik Khadeer Ahamed, 2025). Multiple studies highlight the role of pharmacists' intervention in the need for a personalised medicine approach and advanced clinical intervention, thus managing medications in the complex geriatric population and thereby improving the safety of the dosing of NTI drugs (Lee *et al.*, 2023).

Other Drug related Factors

The number of potential DDI increases with polypharmacy; this, in turn, alters NTI pharmacokinetics (if prescribed). Inaccurate dosing of NTI drugs often leads to either treatment failure or toxic accumulation in the elderly population. In critically ill older patients, decreased renal and hepatic function is compounded by slow drug clearance, leading to accumulation and increasing the risk of toxicity (Varghese *et al.*, 2024). The probability of ADE increases with polypharmacy. ADE in the critically ill older patients often present with symptoms (geriatric syndrome) like confusion, falls, functional decline, or malnutrition, which can be misinterpreted as the ageing process or a new medical condition, leading to a new drug addition (prescribing cascade), further complicating management and increasing DRP (Oakley and Krishnamurthy, 2023). Table 1 outlines high-risk drug classes that account for the majority of clinically significant DRP in elderly ICU patients, emphasising the need for close therapeutic monitoring.

Role of Disease related Factors in Drug related Problems

Organ reserve declines as age progresses and as exhaustion of this reserve, multi organ failure (MOF) is severe in the elderly, especially in those with pre-existing conditions developed from liver and kidney damage (Springer and Nape, 2023). Studies highlight that ADR (often associated with anticonvulsants and sulfonamides) can lead to MOF (which increases the risk of mortality if not treated properly) (Springer and Nape, 2023). Studies using scores like Sequential Organ Failure Assessment (SOFA) or Acute Physiology Age and Chronic Health Evaluation II (APACHE II) emphasise the importance of tapering dosage regimens, careful monitoring for signs of organ dysfunction and implementing strategies for avoiding nephrotoxins (provided with assistance on nutrition) to prevent or mitigate the progression to MOF (Khedkar, 2024; Silva *et al.*, 2024). Research has found a high incidence of serious ADR in the ICU, which were related to the renal/electrolyte system (21%), resulting in acute renal failure and hepatic injuries (Joshua *et al.*, 2009). Current studies are linking algorithms to predict the likelihood of developing MOF based on patient data (Madhan Kumar *et al.*, 2023; Xu *et al.*, 2021). The importance of deprescribing inappropriate medications is a strategy to reduce DRP and the associated risk of MOF. The effectiveness of pharmacist interventions in identifying and resolving DRP in geriatric inpatients and thereby improving patient outcomes, is also an unavoidable matter (Yaacob *et al.*, 2024).

Other Disease related Factors

Chronic diseases and their associated complications, ranging from cardiovascular issues to psychiatric disorders, necessitate complex drug regimens that significantly increase the risk of DRP, particularly when complicated by hypersensitivity or drug allergies (Reddy Peddi *et al.*, 2023). Integrating system-level preventive strategies with clinical pharmacology, geriatrics and critical care practices helps to manage risk factors.

CHALLENGES IN MANAGING DRUG RELATED PROBLEMS

Adverse Drug Reaction in Drug related Problems

ADR are defined as any noxious, undesired, or unintended response to a therapeutic agent, which may be expected or unexpected and may occur at dosages used for the prophylaxis, diagnosis, or therapy of disease, or for modifying physiological function (World Health Organisation (WHO 1972)). ADE is an event when a patient is unintentionally harmed because of drug use, including preventable and non-preventable events. The link between an observed ADR and a suspected drug is always misinterpreted as symptoms or signs of a pathological state, rather than drug effects, leading to the addition of another drug (potentially avoidable), defined as a prescribing cascade (Krishnaswami *et al.*, 2019). Example: A patient developed a cough after starting an ACE inhibitor. A cough syrup with guaifenesin and codeine was prescribed, leading to lethargy (Liu *et al.*, 2009). Approximately 2.9%-8.7% of hospital admissions are associated with ADR (Kongkaew *et al.*, 2008). Prescribing cascade may be investigated through Prescription Sequence Symmetry Analysis (PSSA) methodology (a statistical method to determine if a marker drug prescribed shortly after an index drug

Table 1: High-risk drug classes that account for major drug-related problems in the elderly.

Drug Class	Specific Drugs	DRP in the Elderly	Study Findings
Analgesics	NSAIDs*	Increases the risk of peptic ulcer disease, acute renal failure, stroke/myocardial infarction Exacerbate diseases, including heart failure and hypertension Can interact with several drugs (e.g.: warfarin, corticosteroids)	Drug of choice: Acetaminophen Nonacetylated salicylate (e.g., salsalate) Short half-life NSAID (e.g., ibuprofen) Low-dose opioid/opioid-like agents in combination with acetaminophen (Marcum and Hanlon, 2010; Holt *et al.*, 2010).
	Opioid Analgesics	Elevated risk of delirium and falls	Paracetamol Other opioids (with a lower risk of delirium, e.g., tilidine/naloxone, morphine, oxycodone, buprenorphine, hydromorphone) weak NSAID (e.g., ibuprofen).
Sedatives	Benzodiazepines	Risk of falling (muscle-relaxing effect) with risk of hip fracture Prolonged reaction times Psychiatric reactions (can also be paradoxical, e.g., agitation, irritability, hallucinations, psychosis) Cognitive impairment Depression	short/shorter-acting benzodiazepines zolpidem, zopiclone, zaleplone (at a low dose) opipramol sedating antidepressants (e.g., mirtazapine) neuroleptic drugs of low potency (e.g., melperone, pipamperone) (Marcum and Hanlon, 2010; Holt *et al.*, 2010).
Anticoagulants	Warfarin	Major Bleeding Intracranial Hemorrhage	Symptomatic treatment Dose Adjustment Vitamin K (in case of toxicity) DOAC** Dabigatran Apixaban (Ahmed *et al.*, 2007; Bonanad *et al.*, 2021; Deaton and Nape, 2023).
	Heparin	Bleeding HIT*** Osteoporosis Heparin-Induced Hyperkalemia	Symptomatic treatment Dose Adjustment Protamine Sulfate (in case of toxicity) Direct Thrombin Inhibitors Argatroban Bivalirudin Fondaparinux Danaparoid DOAC (Ahmed *et al.*, 2007; Bonanad *et al.*, 2021; Deaton and Nape, 2023).

Antibiotics	Aminoglycosides	Nephrotoxicity Ototoxicity	Symptomatic treatment Dose Adjustment Less Nephrotoxic Aminoglycoside Tobramycin Netilmicin Select Less Nephrotoxic Antibiotics (Crass *et al.*, 2019; Martel *et al.*, 2025).
	Vancomycin	Nephrotoxicity Vancomycin Infusion Reaction (Red Man Syndrome)	Symptomatic treatment Dose Adjustment Select Less Nephrotoxic Antibiotics Antihistamines Diphenhydramin Cimetidine (Crass *et al.*, 2019; Martel *et al.*, 2025).
Cardiovascular Drugs	Betablockers	Hypotension Bradycardia Bronchospasm Fatigue Hypoglycemia	Symptomatic treatment Dose Adjustment Select another category Antihypertensive Cardio-Selective Beta-Blocker Bisoprolol Metoprolol Hydrophilic Beta-Blocker Atenolol Esmolol (Hanes and Weir, 2001; Sica, 2004).
	ACE**** Inhibitors	Hypotension Acute Kidney Injury Hyperkalemia Dry Cough	Symptomatic treatment Fluid Management Dose Adjustment Potassium Binders/ Potassium Restriction Select another category Antihypertensive (Hanes and Weir, 2001; Sica, 2004).

*NSAIDs-Non-Steroidal Anti-Inflammatory Drugs, **DOAC- Direct Oral Anticoagulants, ***HIT-Heparin-Induced Thrombocytopenia, ****ACE-Angiotensin Converting Enzyme

caused an ADR). Many studies use a combination of both PSSA and expert review to confirm and validate them in specific patient cases (Mohammad *et al.*, 2024). The prevalence of ADR among critically ill older inpatients has specifically enhanced hospital readmissions (prevalence of 9% of drug related readmissions in older adults) and a higher risk of developing future DRP (Prasad *et al.*, 2024).

Limited Geriatric Dosing Guidance for Intensive Care Unit Drugs

Research highlights that limited geriatric dosing guidance leads to DRP (PIM, ADE and errors) (Rothschild *et al.*, 2005). Historically, older adults have been removed from clinical trials. These result in a lack of high-quality evidence on the efficacy and safety of many medications, particularly those used in the complex ICU environment, leading to under-/over dosing of drugs and PIM. There remains a critical need for extensive research targeting the pharmacokinetic complexities of older adults in intensive care to fill the current void in evidence-based dosing standards (Ding and Wang, 2021). Integrating clinical pharmacists and implementing standard guidelines and criteria (e.g., Beers, Screening Tool of Older Persons' Prescriptions and Screening Tool to Alert to Right Treatment STOPP/START) into the ICU team can help minimise all drug related issues and prescribing decisions (Keche *et al.*, 2022).

Other Less-Known Facts

The high-pressure environment of critical care often fosters expedited clinical decision-making, insufficient patient education, and suboptimal transitions of care. Such systemic challenges, along with clerical errors in prescribing, significantly elevate the incidence of medication errors (Kivilienė *et al.*, 2024).

CLINICAL IMPLICATIONS

Drug related problems contribute to prolonged intensive care unit/hospital stays and higher mortality rates

Patients with DRP had a longer hospital stay. The total number of patient days was 4,868 (79.7 DRP per 1000 patient days) (p<0.001) (Çakır *et al.*,2024). The mean number of drugs was significantly higher in the group with DRP than in the group without DRP (p<0.05) (Pehlivanli *et al.*,2023). Also, the rate of mortality (due to DRP) was higher in general hospital stays (p<0.05) (Albayrak *et al.*, 2022).

Patients with medical errors and adverse events had significantly longer hospital stays (by an average of 8.9 days) and ICU stays (by an average of 6.8 days) (Cantor *et al.*, 2022). The average length of stay for patients with DDI was 15 days and 8 days for patients not exposed to DDI (Moura *et al.*, 2009) The mortality in adult ICU patients with DDI was 66.7% (Kyomya *et al.*, 2023).

Potential for Secondary Complications: Delirium, Renal Injury, Infection Risk

The DRP role in causing or exacerbating secondary complications such as delirium, Acute Kidney Injury (AKI), and infections is notable. These complications are from inappropriate drugs of choice, dosing errors and poor monitoring. 79.3% of participants with kidney dysfunction (both acute kidney injury and chronic kidney disease) had at least one DRP (Garcia *et al.*,2024). Drug-induced acute kidney injury (DI-AKI) was a significant cause of AKI, accounting for 19.3% of cases (Pang *et al.*, 2022). AKI significantly increased the risk of delirium, which enhanced the stay in hospital and mortality (Kyriakopoulos and Gupta, 2024). Failure to adjust drug dosages in impaired kidney function can lead to drug accumulation, leading to toxicity and subsequent delirium (Piccirillo *et al.*, 2023).

Impact on post-Intensive Care Unit recovery and readmissions

DRPs contribute to readmissions and poor recovery outcomes, which are very common in patients discharged from critical care settings, causing unnecessary healthcare costs. 9% of older adults discharged from the hospital experienced a drug related readmission, with up to 22% of these being preventable (Prasad *et al.*, 2024). DRP are common in post-ICU patients and significantly contribute to poor recovery outcomes and hospital readmission (Weber *et al.*, 2025). The specific roles of ICU clinical pharmacists are detailed in Figure 1, and the corresponding pharmacist-led initiatives designed for DRP prevention are presented in Figure 2.

Barriers in the Pharmacist Role

Insufficient support from hospital management to implement clinical pharmacy services and a lack of specific financial compensation or reimbursement models for clinical services are strong barriers to the implementation and expansion of

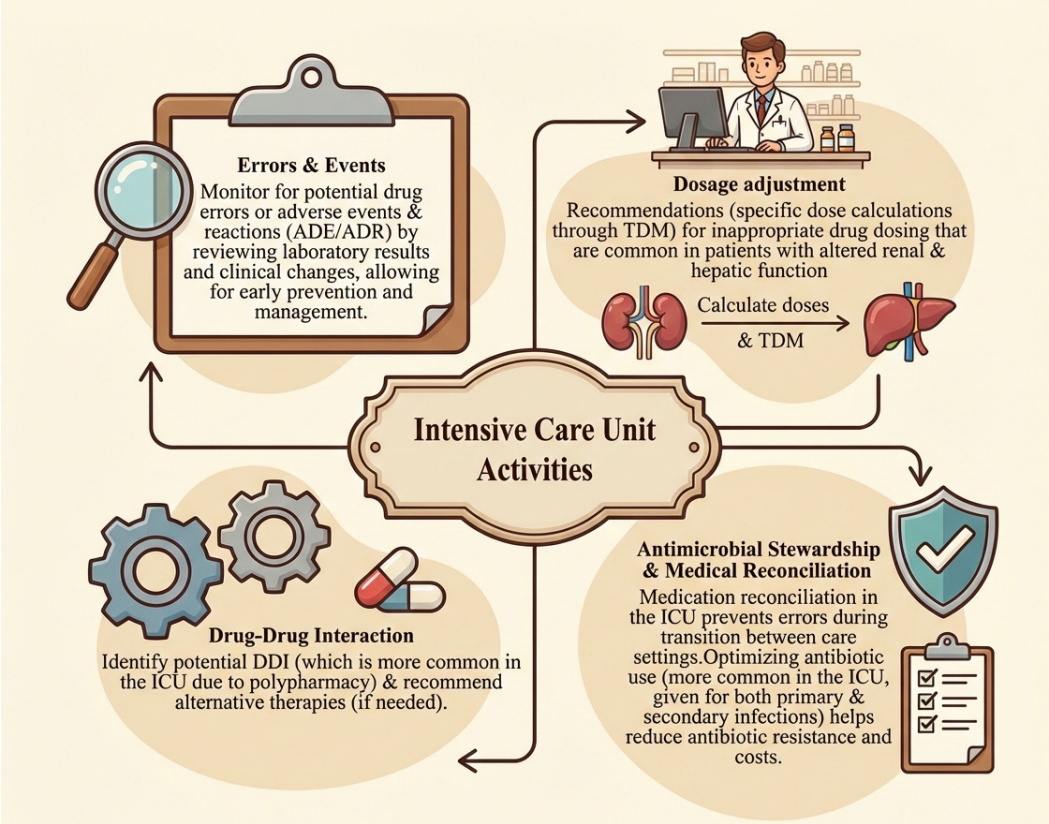

Figure 1: Role of clinical pharmacist in Intensive Care Unit (ICU) (Yin *et al.*, 2023).

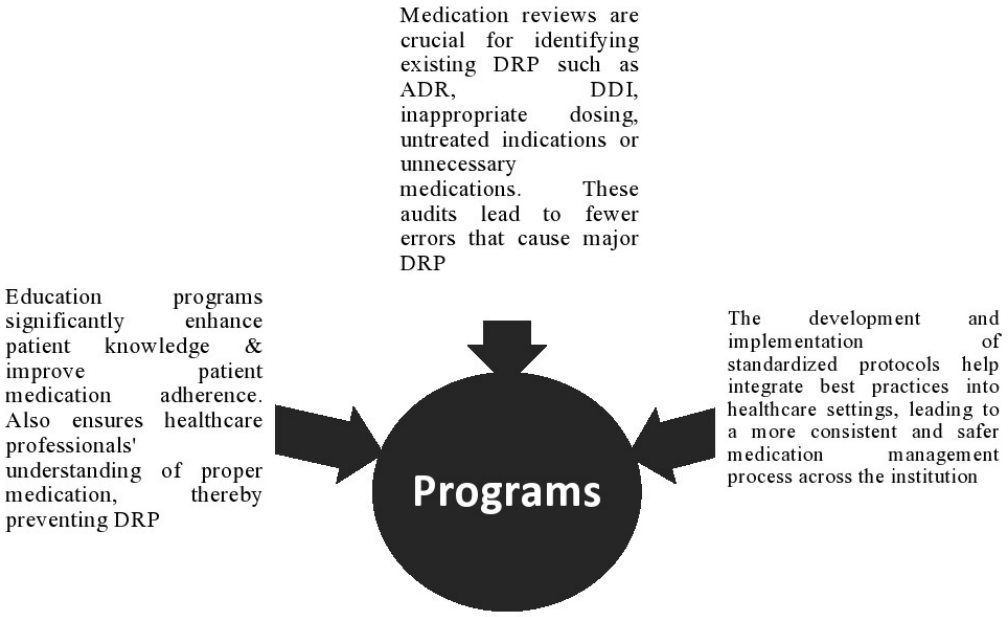

Figure 2: Programs to be implemented and developed by clinical pharmacist (Yin *et al.*, 2023).

multifaceted clinical pharmacy programs. In the absence of formalised guidelines and standardised job descriptions at the institutional level, the clinical pharmacist's role remains underutilised and frequently misunderstood as purely distributive. However, pharmacist integration is not ancillary but fundamental to ensuring patient safety and achieving optimal pharmacotherapeutic outcomes in high-acuity settings.

CONCLUSION AND FUTURE DIRECTIONS

Drug-related problems and their Multidimensional Impact

DRP remains highly prevalent, especially in critical care settings, due to the complexity of patients' conditions and polypharmacy (Cakir *et al.*, 2024). DRP contributes to prolonged stays in general hospital settings and in the ICU, thus imposing an unnecessary burden of additional healthcare costs (Cantor *et al.*, 2022). ADE and DDI are commonly associated with longer hospital stays. Key predictors in ADE and DDI are polypharmacy, the number of co-morbidities, and age related changes. DRP role in causing or exacerbating secondary complications (delirium, renal injury (AKI), and infections) or new health problems (misinterpreted as new diseases and treated) is notable (Garcia *et al.*, 2024; Pang *et al.*, 2022; Kyriakopoulos and Gupta, 2024). Readmissions and poor recovery outcomes are very common in patients discharged from critical care settings. A higher number of DRP is associated with a negative impact on patients' Health related Quality of Life (HRQoL), leading to significant drug related morbidity and mortality each year. Unresolved DRP results in unnecessary healthcare expenses and loss of productivity, too (Cantor *et al.*, 2022).

Multidisciplinary and Preventive Focus

Preventive measures on DRP should focus on integrating professional expertise from various fields to provide patient-centred care. Teamwork (including physician, clinical pharmacist, and nurse), together with the use of electronic tools and standard guidelines and criteria, helps to develop effective patient care and treatment plans (Yin *et al.*, 2023).

Emerging Tools

Use of VigiLanz (clinical surveillance and patient safety solution) and VigiFlow (pharmacovigilance database system) ensures patient safety**.** Artificial Intelligence-Powered Apps integrated into mobile phones and smart devices help to send alarms to confirm medication ingestion and provide personalised reminders and educational content, which has been shown to improve adherence. AI models are to be trained on multiple datasets to improve Machine Learning (ML). The integration of AI with Pharmacogenomics Clinical Annotation Tool (PharmCAT), Electronic Pharmacogenomics Assistant (ePGA) etc., tools enables the selection and dosing of drugs tailored to a patient's specific genetic profile, improving efficacy and minimising adverse effects (Srivastav *et al.*, 2025). Integrating pharmacist-led safety strategies with advanced decision-support systems holds promise for minimising DRP and improving clinical outcomes among critically ill older adults.

DECLARATIONS

The figures and tables are original illustrations developed independently by the authors using data from the cited references. They are not reproduced or adapted from previously published sources and therefore do not contain any copyrighted material.

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ABBREVIATIONS

DRP: Drug related problem; **ICU:** Intensive Care Unit; **WHO:** World Health Organization; **ADE:** Adverse Drug Event; **ADR:** Adverse Drug Reaction; **DDI:** Drug-Drug Interactions; **PCNE:** Pharmaceutical Care Network Europe Association; **DD:** Drug Duplication, **CrCl:** Creatinine Clearance; **AUC:** Area Under the Curve; **BMI:** Body Mass Index; **ADME**: Absorption, Distribution, Metabolism and Excretion; **GFR:** Glomerular Filtration Rate; **NTI:** Narrow Therapeutic Index; **TDM:** Therapeutic Drug Monitoring; **PIM:** Potentially Inappropriate Medication; **MOF:** Multi Organ Failure; **SOFA:** Sequential Organ Failure Assessment; **APACHE II:** Acute Physiology Age and Chronic Health Evaluation II; **PSSA:** Prescription Sequence Symmetry Analysis; **DI-AKI:** Drug-induced acute kidney injury; **HRQoL:** Health related Quality of Life; **PharmCAT:** Pharmacogenomics Clinical Annotation Tool; **ePGA:** Electronic Pharmacogenomics Assistant; **STOPP:** Screening Tool of Older Persons' Prescriptions; **START:** Screening Tool to Alert to Right Treatment.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest

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