

DRUG-RELATED PROBLEMS IN EMERGENCY DEPARTMENT VISITS AND INTENSIVE CARE UNITS AT HEALTHCARE FACILITIES IN SAUDI ARABIA: A REVIEW OF THE LITERATURE

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ABSTRACT

The burden of drug-related problems (DRPs) is becoming an issue of healthcare concern. It has been responsible for many intensive care unit (ICU) admissions and emergency department (ED) visits in Saudi Arabia. We aim to summarise available data on ED visits and ICU admissions linked to DRPs in Saudi Arabia and provide recommendations for preventive measures. A systematic search of the literature was conducted using PubMed and Google Scholar databases to identify eligible studies. The review included research on ED visits and ICU admissions linked to DRPs performed in Saudi Arabia from the database's inception to January 2020. Study selection, data extraction and assessment were performed based on the Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) guidelines. The initial search of literature generated 267 articles. After the study selection, 15 articles met our eligibility criteria and were included in the review. The commonly implicated DRPs were adverse drug reactions, medication non-adherence, drug overdose and drug interactions. Central nervous system drugs and cardiovascular drugs were the most frequently involved drugs. Most of these visits resulted in moderate harm. The prevalence of DRPs associated with ED visits and ICU admissions is high in Saudi Arabia. Sixteen out of a hundred ED visits and ICU admissions are related to DRPs. Therefore, the Saudi government should implement interventions to improve the awareness of rational drug use in the general public.

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INTRODUCTION

Drug-related problems (DRPs) is defined by the Pharmaceutical Care Network Europe (PCNE) as 'an event or circumstance involving drug therapy that actually or potentially interferes with the desired health outcome' (PCNE 2017). A DRP that has not been detected and addressed could increase mortality, morbidity and healthcare costs. Previous studies have shown that DRPs are of significant public health problem concern in the general population. The incidence of DRPs leading to hospitalisation has been reported to be as high as 24% (Zed 2005). It has been estimated that morbidity and mortality associated with DRPs account for 17 million emergency department (ED) visits and 8.7 million hospital admissions (Anderson *et al.* 2002). This burden accounts for the in-hospital cost of USD76.6 billion to more than USD177.4 billion between 1995 and 2000 (Anderson *et al.* 2002). It may be difficult in the developing countries to obtain national data on DRP-linked burden due to inadequate national surveillance systems and limited studies on DRPs.

In Saudi Arabia, available data shows that DRP occurrences leading to hospitalisation are common in the general public (Alsaidan *et al.* 2018). This frequent occurrences of DRP could be associated to widespread irrational use of both prescription and over the counter (OTC) medication in the general population as many prescriptions only medicines (POM) are purchased without a valid prescription in the Kingdom of Saudi Arabia (KSA) (Alsaidan *et al.* 2018). Therefore, addressing the DRPs-linked burden has become a public health priority, given the increasing use of medication and chronic diseases.

ED is one of the hospital settings that cater to patients with acute medical conditions. A high prevalence of DRPs-related ED visits indicates how serious the burden of DRP is in the community (Jatau *et al.* 2019; Bakhaidar *et al.* 2015; Alanazi, Al-Jeraisy and Salam 2015). Several studies have been conducted to assess the burden of DRPs-linked to ED visits and intensive care units (ICU) admissions at various healthcare centres in KSA (Alghamdy *et al.* 2015). A summary of these studies will provide a comprehensive representation of what has been explored in KSA. It will help identify the literature gaps that would guide the design and implementation of interventions to reduce the harm associated to medication use in clinical practice and the general public. Therefore, we aimed to summarise studies on DRPs-linked to ED and ICU conducted at healthcare facilities in KSA and make recommendations for targeted interventions.

METHODS

Literature Search

The literature was searched to identify studies conducted on DRPs-linked ED visits and ICU admissions at KSA healthcare facilities. The search was performed using Medline via PubMed database. Other relevant articles were identified through Google Scholar and manual search of the reference lists of included articles. For the Google Scholar search, the first 200 search results, sorted according to the relevance ranking were considered for inclusion, based on a previous recommendation (Bramer *et al.* 2017). The search strategies used for the selected databases are provided in Appendix A.

Eligibility Criteria

Peer-reviewed articles written in the English language from the inception of the databases to January 2020 were eligible for inclusion based on the following criteria: a) studies on any DRPs-linked visit to ED or ICU, b) studies conducted at the EDs or ICU of healthcare facilities in Saudi Arabia and c) any patient population. Studies were excluded if performed in other hospital units/wards (for example, outpatient departments, inpatient wards or other units outside ED and ICU). Also, studies that are explicitly reporting illicit drugs use or their untoward effects were excluded.

In this study, ED visits or ICU admissions linked to DRPs refers to any visit to the ED or ICU with a primary complain due to DRPs, such as adverse drug reactions (ADR), medication error (ME), medication non-adherence, sub-therapeutic dose, overdosage, therapeutic drug failure and wrong drug selection.

Literature Selection

Articles obtained from the systematic search were exported to EndNote X8 TM (Clarivate Analytics, Philadelphia, USA), where the duplicate studies were identified and excluded. The full texts of the articles were assessed for eligibility following screening for titles and abstracts.

Data Extraction and Assessment

The following information was extracted from the included studies: author/publication year, study design, sample size, the prevalence of DRPs-linked ED visits, common drugs reported, class of DRPs involved, and outcomes of the ED visits or ICU admissions. The summary of the data extracted is presented in Table 1. This review was conducted and reported based on the Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) checklist.

RESULTS

Search Results

The initial search of the literature from the two databases generated 267 records and four relevant articles were obtained through a manual search of included studies. The screening for duplicates removed 18 articles and 153 articles were excluded during the title and abstract screening. A total of 81 articles were excluded based on the eligibility criteria. Finally, 15 articles that met up the eligibility criteria were included in this study. Figure 1 demonstrates the literature selection process using the PRISMA flowchart.

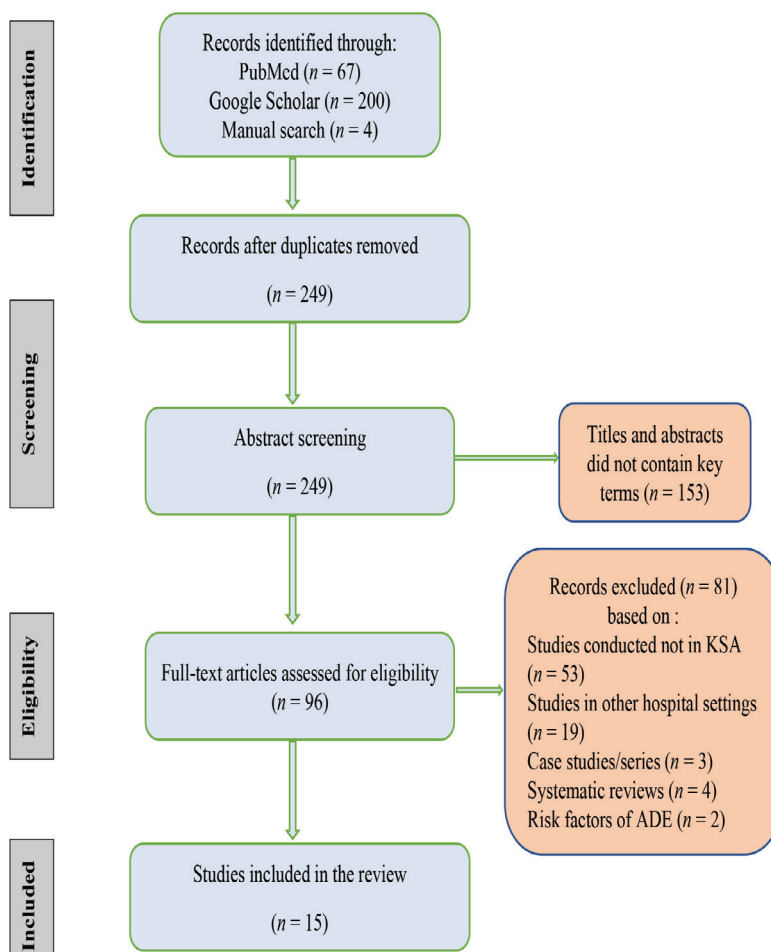


Figure 1: PRISMA flow diagram illustrating the literature screening process.

Description of Included Studies

Of the 15 studies included, 9 were prospective cohort study design (AlAzmi *et al.* 2019; Ragab and Al-Mazroua 2015; Mohamed 2014; Al-Arifi *et al.* 2014; Rashed *et al.* 2012; Al-Hazmi 1998; Al-Olah and Al-Thiab 2008; Al-Sekait 1990; Alayed *et al.* 2019); five were retrospective case review (Alghadeer *et al.* 2018; Mantas 2017; Randhawa *et al.* 2015; Alghamdy *et al.* 2015; Bakhaidar *et al.* 2015) and one cross-sectional study (Alanazi, Al-Jeraisy and Salam 2015). Generally, all the studies were conducted in four major cities, namely Riyadh (seven studies: Al-Sekait 1990; Al-Olah and Al Thiab 2008; Rashed *et al.* 2012; Al-Arifi *et al.* 2014; Mohamed 2014; Mantas 2017; Alghadeer *et al.* 2018), Jeddah (four studies: AlAzmi *et al.* 2019; Alanazi, Al-Jeraisy and Salam 2015; Bakhaidar *et al.* 2015; Al-Hazmi 1998), Dammam (three studies: Randhawa *et al.* 2015; Alghamdy *et al.* 2015; Ragab and Al-Mazroua 2015) and Unaizah (one study: Alayed *et al.* 2019). In terms of the study settings, four were conducted in ICU (Randhawa *et al.* 2015; Rashed *et al.*

2012; Mohamed 2014; Ragab and Al-Mazroua 2015), eight were performed at ED (Alayed *et al.* 2019; Alghadeer *et al.* 2018; Mantas 2017; Alghamdy *et al.* 2015; Alanazi, Al-Jeraisy and Salam 2015; Bakhaidar *et al.* 2015; Al-Olah and Al Thiab 2008; Al-Arifi *et al.* 2014), while two were conducted at both ED and ICU (AlAzmi *et al.* 2019; Al-Hazmi 1998). One of the studies was not specific in terms of setting (Al-Sekait 1990). Six of the studies were conducted in children population (Alghadeer *et al.* 2018; Ragab and Al-Mazroua 2015; Rashed *et al.* 2012; Al-Hazmi 1998; Al-Sekait 1990; AlAzmi *et al.* 2019). All the studies were conducted in tertiary healthcare facilities.

Prevalence of DRPs in the ED/ICU

The studies were heterogeneous in terms of research outcomes, with some focusing on general DRPs, while others on a specific type of DRP. This heterogeneity will make the study comparison difficult. Seven of the studies focused on all kinds of DRP and reported a prevalence in the range of 3.6% to 35.9% (AlAzmi *et al.* 2019; Mantas 2017; Randhawa *et al.* 2015; Mohamed 2014; Al-Arifi *et al.* 2014; Rashed *et al.* 2012; Al-Olah and Al Thiab 2008). Seven studies assessed the individual type of DRP, namely poisoning, mostly among paediatric population 4.9% to 7.2% (Al-Sekait 1990; Al-Hazmi 1998; Bakhaidar *et al.* 2015; Ragab and Al-Mazroua 2015; Alghadeer *et al.* 2018), prescription error (46.2%) (Alanazi, Al-Jeraisy and Salam 2015) and ADR (0.8%) (Alayed *et al.* 2019). Overall, the prevalence of DRPs from all the included is 16.0%. Table 1 illustrates the prevalence of DRPs-linked ED/ICU at healthcare facilities in KSA.

Table 1: Characteristics of the studies on DRPs-linked ED visits and ICU admissions in the KSA (n = 15).

Author/year	Study design	Settings/ Population	Prevalence of DRPs n (%)	Common DRPs (%)	Drugs implicated	Clinical outcomes
Al Azmi et al. (2019)	Prospective observational	ED and ICU King Abdulaziz Medical City, Jedda 655 Pediatrics	235 (35.9%)	Dose selection (78%).	Anti-infective (32.9%) Blood and blood- forming organs (25%), alimentary tract and metabolism (25%)	Moderate (94.3%) Minor (5.4%) Severe (0.36%)
Alayed et al. (2019)	Prospective cohort	ED, King Saud Hospital, Unaizah 3314 visits	38 (0.8%)	ADR (0.8%)	Painkillers (21.1%) CNS drugs (10.5%), haematology (10.5%), psychiatry (10.5%),	Mild (15.1%) Moderate (71.1%), Severe (13.2%) Death 2
Alghadeer et al. (2018)	A retrospective cross-sectional descriptive study	ED, King Khaled University Hospital, Riyadh 735 children >12 years	735 (1.7%)	Drugs accidentally ingested (70%)	Analgesics (18.8%), antihistamines (13%), cardiovascular drugs (12.3%), vitamins (9.6%), antipsychotics (5.5%)	Not specified
Mantas (2017)	A retrospective study review of medication safety record	ED, King Faisal Specialists Hospital and Research Center, Riyadh 698 cases	92 (13.2%)	ADR 92 (46.7%) Drug prescribing (30.4%), compliance (14.1%), drug dosing (8.7%)	Antihypertensive (18.5%) Chemotherapeutics (17.4%) Anticoagulant (15.2%) Anti-diabetics (11.9%).	Moderate (82.6%) Severe (13.0%) Mild (4.3%)

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Table 1: (continued)

Author/year	Study design	Settings/ Population	Prevalence of DRPs n (%)	Common DRPs (%)	Drugs implicated	Clinical outcomes
Randhawa <i>et al.</i> (2015)	Retrospective file review	ICU, King Fahad Hospital of the University, Dammam 193 cases	33 (17.1%)	Drug interactions (18.2%),	Anticoagulants (24.2%), antiepileptic (18.2%), immunosuppressants (12.1%), antibiotics (12.1%), antihypertensive (9.1%) and antipsychotics (6.1%)	Preventable (60%) Death (4.1%)
Alghamdy <i>et al.</i> (2015)	Retrospective file review	ED, King Fahad Hospital of the University, Dammam 143,833 total visits	253 (4.5%)	Overdose toxicity and side effects (19.8%), drug-interactions (11.5%), accidental and suicidal drug ingestions (10.3%), drug abuse (7.1%), drug allergy (4%)	CNS drugs Enzyme inhibitors and inducers Opioids, Benzodiazepines, and alcohols Antibiotics	Preventable (70%) Possibly preventable (26.5%) Death (4%)
Ragab and Al-Mazroua (2015)	Prospective database review	PICU, Dammam Maternity and Children Hospital 5,838 children <15 years	1272 (21.8%)	Accidental pediatric toxicity	Drug medication (63.2%) Anticoagulant (34.1%)	Mild (16.3%) Moderate (14.7%) Severe (4%)
Alanazi, Al-Jeraisy and Salam (2015)	Cross-sectional	ED, King Abdul-Aziz Medical City, Jeddah 5,752 cases of patients with infection	46.2%	Medication error related to an antibiotic: Selection (2%) Dosage (22%) Frequency (4%) Duration (29%)	Penicillin, cephalosporin, and macrolide	Not reported

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Table 1: (continued)

Author/year	Study design	Settings/ Population	Prevalence of DRPs n (%)	Common DRPs (%)	Drugs implicated	Clinical outcomes
Mohamed (2014)	Prospective cohort	ICU, Riyadh Care Hospital 2,389 all patients	86 (3.6%)	Drug overdose (52%) Adverse drug effect (22%) Failure to receive drug (15%) Sub therapeutic dosage (7%) Drug use without indication (3%)	Hypoglycemics (17%) Tranquilizers (14%) Antiepileptic (13%) Antibiotics (7%) Antihypertensive (7%)	Death (4.6%) Severe (2.3%)
Bakhaider et al. (2015)	Retrospective cohort	ED, King Khalid National Guard Hospital, Jeddah 129 cases of a drug overdose and chemical poisoning	Not reported	Drug overdose (92.2%) Chemical poisoning (7.0%)	Analgesics/NSAIDs (20.4%) Anticonvulsants (17.2%) Antihypertensives (11.5%)	No death was reported 45% were given activated charcoal
Al-Arifi et al. (2014)	Prospective cohort observational study	ED, Riyadh Military Hospital, Riyadh 300 patients	56 (18.7%)	Adverse drug reaction (30.4%) Non-compliance (30.4%), Untreated conditions (10.7%) Drug interactions (7.1%)	Antihypertensive (21.5%) Anticoagulants (14.3%) Immunosuppressant (12.5%) Chemotherapeutics (10.7%)	Moderate (48.2%) Mild (37.5%) Severe (14.3%)
Rashed et al. (2012)	Prospective cohort	ICU, King Abdul-Aziz Medical City, Riyadh 364 paediatric	186 (51.1%)	ADR (6.2%), drug choice problem (11.2), dosing problem (70.5%), drug use problem (1.9%), interactions (6.6%)	Amoxicillin (17%), morphine (1.8%), salbutamol (0.8%)	Preventable 80.3% Minor 72.2% Moderate 27%

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Table 1: (continued)

Author/year	Study design	Settings/ Population	Prevalence of DRPs n (%)	Common DRPs (%)	Drugs implicated	Clinical outcomes
Al-Olah and Al Thiab (2008)	Prospective, observational study	ED, King Abdul-Aziz Medical City, Riyadh	82 (14.7%)	Noncompliance (47.2%) Adverse Drug reaction (24.5%) Drug overdose (11.3%) Sub therapeutic dose (7.6%)	Insulin (n = 10) Anti-asthmatics (n = 7) Chemotherapeutic agents (n = 6) Anticoagulant (n = 4)	Mild (83.0%) Moderate (3.8%) Severe (13.2%)
Al-Hazmi (1998)	Prospective studies using an administered questionnaire	ED and ICU, King Abdulaziz Hospital, Jeddah 1954 children up to 12 years	140 (7.2%)	Accidental poisoning of household chemicals and drugs	Anticonvulsant (4.3%) Antihistamines and decongestants (4.3%) Antipsychotic (3.6%) Antiemetic (3.6%)	Moderate and mild (62.5%) Severe (71.9%)
Al-Sekait (1990)	Prospective observational study	Children's Hospital, Riyadh Armed Forces Hospital, Riyadh King Khalid Hospital, Riyadh	794 (4.9%)	Accidental poisoning of household chemicals and drugs	Analgesics/antipyretics (19.4%) Contraceptives (7.3%) Iron supplement syrup (6.5%) Barbiturates (4.2%), Cough syrup (3.1%), antiemetic (2.8%)	Not specified

Common Types of DRPs Identified

The most common DRPs reported by the studies that focused on all DRPs were ADRs, reported by five out of the seven studies (5/7), medication non-adherence (4/7), medication overdose (4/7) and medication interactions (4/7). Other DRPs reported were sub-therapeutic doses, untreated indications, drug allergy, and drug selection (Table 1). As high as 46.7% prevalence of ADR and medication non-adherence were reported, respectively (Al-Arifi *et al.* 2014; Mantas 2017). A higher prevalence of 52% of medication overdose and 18.2% of medication interactions were reported by previous researchers (Mohamed 2014; Randhawa *et al.* 2015).

Drug Classes Most Frequently Involved

The most common classes of medications implicated in the DRPs-linked ED visits and ICU admissions included central nervous system (CNS) drugs such as tranquilisers and anti-epileptics, reported by nine studies ($n = 9$). Others include analgesics/non-steroidal anti-inflammatory drugs (NSAIDs) ($n = 6$), antibiotics ($n = 6$), cardiovascular system (CVS) such as antihypertensives ($n = 6$), anticoagulants ($n = 5$), chemotherapeutic agents ($n = 5$), anti-diabetics including insulin ($n = 3$) and antipsychotics ($n = 3$). A high percentage (34.1%) of DRPs linked specifically to ICU admission was due to anticoagulant use (Ragab and Al-Mazroua 2015). Antibiotics account for up to 33% of the DRPs in a study by AlAzmi *et al.* (2019). Anti-hypertensives (CVS drug class) were involved in 21.5% of cases of DRPs in a study by Al-Arifi *et al.* (2014). Analgesics/NSAIDs were frequent in as high as 20.4% of DRPs in a retrospective study in Jeddah (Bakhaidar *et al.* 2015).

Clinical Outcomes

The injury caused due to the DRPs in this review was classified into severe, moderate and minor. Cases of death linked to the DRPs were also recorded. Most (up to 94.3%) of the ED visits' clinical outcomes due to the DRPs were moderate (AlAzmi *et al.* 2019). In a study focusing on poisoning cases among children 12 years and below, DRPs resulted in 71.9% severe outcomes (Al-Hazmi 1998). Four studies reported death due to DRPs (Mohamed 2014; Alghamdy *et al.* 2015; Randhawa *et al.* 2015; Alayed *et al.* 2019). In a prospective cohort study conducted at the ICU unit of Riyadh Care Hospital, 4.6% of death was contributed by DRPs (Mohamed 2014). Three of the studies did not report the level of harm caused by DRPs during the patient visit (Alghadeer *et al.* 2018; Alanazi, Al-Jeraisy and Salam 2015; Al-Sekait 1990). The majority of the DRPs were preventable. Rashed *et al.* (2012) reported that 80.3% of DRPs-linked ED visits were preventable (Rashed *et al.* 2012).

DISCUSSION

The current study summarises the literature on ED visits and ICU admissions linked to DRPs at KSA healthcare facilities. Prevalence from the included studies suggests that 1 out of 16 ED visits at healthcare institutions in KSA is related to DRPs. This finding is comparable to a previous study by Zed (2005). This shows that the burden of DRP is high in KSA and thus calls for interventional measures to improve patient safety and reduce healthcare costs.

Fortunately, up to 80% of the DRPs reported were preventable. This preventability further illustrates the possibility of interventions to prevent further occurrences.

ADR was the most common DRP reported to be associated with ED visits. A population-based study in KSA showed that more than 25% of the population had experienced ADR in the last 12 months (Almubark *et al.* 2019). The reported high incidence of ADR among the general population in KSA may explain our findings. Further, ADR under-reporting in KSA may also be a reason for the high ADR rate reported in this study. Intervention to improve ADR reporting at a large tertiary hospital has been trialled in KSA. Ali *et al.* (2018) used incentives to enhance ADR reporting over two years. At the end of their study period, the number of ADR reports per month increased by 40.6% (Ali *et al.* 2018).

The high frequency of medication non-adherence may be related to the increasing rate of chronic diseases in KSA (Mokdad 2014). Medication non-adherence has been common among people with chronic conditions in the KSA (Alkhamis *et al.* 2019; AlQarni *et al.* 2019). Medication overdose was commonly implicated in many studies. This is a severe problem that requires an urgent intervention among the general population in KSA. An epidemiological data covering a 5-year assessment of medication overdose shows a higher rate of medication overdose in KSA (Al-Jaser, Epi and Awofeso 2013). The high frequency of this problem may also be explained by the widespread nonmedical use of prescription drugs (Martins and Ghandour 2017) and limited provision of poison information services by the Drug Information Centers (DICs) and Drug and Poison Information Centers (DPICs) in KSA (AlNasser, Khojah and AlQahtani 2019). Interventions targeted at improving the level of awareness are needed to prevent this burden.

The most involved drugs in ED visits and ICU admissions were CNS, CVS, analgesic/NSAIDs, antibiotics and anticoagulants. These classes of drugs have been previously identified to be widely involved in ED visits related to drugs (Jatau, Aung and Kamauzaman 2015). These medications are among the top 10 most used drugs in KSA (AlKhamees *et al.* 2018). And despite the existing laws, these drugs are sold in community pharmacies without a valid prescription in KSA (AlKhamees *et al.* 2018). This further contributes to the self-medication and potentially leading to ED visits due to DRP. Improved patient education, counselling and enforcement of drug laws may prevent this burden.

Cardiovascular and CNS disorders were the most presented diagnoses among the patients in this review. Others include gastrointestinal disorders, followed by respiratory ailments. The high rate of cardiovascular and CNS disorders could be due to accidental chemicals and poison ingestion and non-compliance with medication. The high number of cardiovascular patients in this study could be related to the previously reported high prevalence of cardiovascular and CNS diseases in KSA (Kumosani, Alama and Iyer 2011; AlKhamees *et al.* 2018; Tyrovolas *et al.* 2020). Increased risk of drug abuse is usually associated with CNS drugs among patients, as reported in previous studies. It could be the reason for the high rate of DRPs due to CNS drugs identified (Ibrahim *et al.* 2018).

Interventions

According to the UK National Institute for Health and Care Excellence, successful implementation of intervention should be guided by a conceptual framework (National Institute for Health and Care Excellence 2014). Therefore, sustainable interventions to prevent ED visits related to DRPs in KSA should be designed and implemented based on a conceptual framework. Jatau *et al.* (2019) developed a conceptual model that would guide the design and implementation of interventions to prevent DRPs leading to ED (Jatau

et al. 2019). According to the model, interventions should be targeted at factors related to patients' sociodemographic characteristics, community, healthcare settings, policy and healthcare personnel (Jatau *et al.* 2019).

Sociodemographic factors such as level of education, patients knowledge of medication use, improving the awareness and understanding of patients through counselling, and the use of beer's criteria screening tools can help reduce DRPs (Panel *et al.* 2019). Therefore, providing appropriate information to patients (especially the young or aged), awareness of drug misuse and abuse, and providing more primary healthcare facilities for easy patient access will significantly reduce ED visits and ICU admissions due to DRPs.

The second aspect of the intervention is improving patients' clinical factors, which involves looking into the patient's clinical characteristics, such as chronic diseases and multiple diseases, which may lead to polypharmacy. Polypharmacy leads to drug interactions and adverse drug reactions (Hayes, Klein-Schwartz and Barrueto 2007). Screening Tool of Older People's Prescriptions, the Screening Tool to Alert to Right Treatment (STOPP/START), Computerised Physician Order Entry (CPOE) and the use of Telemedicine are some of the essential clinical interventions to assist clinicians and patients in making the best decisions to reduce the rate of DRPs (Brown *et al.* 2016).

Another vital aspect of the intervention is through research and development. A valuable data gathering, pharmacovigilance surveillance, and more studies on the event can give a clearer picture, rate and associated factors of the DRPs. This will help in having more effective interventions to reduce the rate of DRPs presented in the ED.

Strengths and Limitations

This review is among the first in KSA to compile studies on ED visits and ICU admissions linked to DRPs and give a unified picture of the problem. It will further help decision-makers in identifying appropriate solutions and interventions to the problem. However, there are not enough studies in the KSA to give a broader picture of the incidence.

CONCLUSION

The prevalence of ED visits and ICU admissions linked to DRPs is widespread and a significant public health problem in KSA. ADR, medication non-adherence, medication overdose and medication interactions were the most reported DRPs related to ED visits and ICU admissions in KSA. Anticoagulants, anti-diabetics, antibiotics and medications that affect the CNS and CVS were the most frequently implicated drug classes in ED visits and ICU admissions. Fortunately, about 80% of the DRPs were preventable. Therefore, there is a need for sustainable interventions targeting the general public, patients, healthcare systems and healthcare personnel to prevent DRPs and improve clinical outcomes in KSA.

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APPENDIX A

The search strategies used for the selected databases.

No.	Search strategies
Medline through PubMed	
#1	"drug-related problem"
#2	"adverse drug event"
#3	"Adverse drug reactions"
#4	"medication error"
#5	#1 OR #2 OR #3 OR #4
#6	emergency
#7	"intensive care unit"
#8	#6 OR #7
#9	"Saudi Arabia"
#10	#5 AND #8 AND #9
Google Scholar (first 20 pages were considered)	
#1	"drug-related problem" OR "adverse drug event" OR "Adverse drug reactions" OR "medication error" AND "emergency department" OR "emergency room" OR emergency unit" OR "intensive care unit" AND "Saudi Arabia"