SYSTEMATIC REVIEW

Impact of errors in medication on healthcare: A systematic review

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Abstract

Background: Medication Errors (ME) are a major global health concern across all health systems and can negatively impact patient safety, health expenditure, and health system efficiency, especially in Low- and Middle-Income Countries (LMICs). *Aim and Objectives:* Assessing the risks associated with medications and the acting risk mitigation interventions, as well as the building of research capacity at all levels, health care systems and disciplines. *Methods:* All relevant disciplines within the health care system and mitigation plans were examined, using all available databases and search engines to identify and query relevant literature. *Results:* Complications, secondary adverse outcomes and a summary of the influenced impact of errors were retrieved and compiled from 23 scattered published articles among the health databases. These errors and adverse outcomes lead to a considerable amount of death, morbidity, higher length of stay in health institutions, and higher costs of health care. The outcomes illustrate the necessity of overcoming these knowledge gaps and the need to employ integrative approaches to mitigate MEs, and improve the patient safety of the health care system and overall. The gaps in the estimated magnitudes of data errors are due to gaps in definitions, typologies, and methods of analysis. *Conclusions:* In the pursuit of safety improvement across disciplines in diverse fields and work environments, utmost compliance with instructions, restructuring of checklists, and adherence with ethics are the main pillars of mitigating errors and achieving a healthy system with improved care. Focus should be on health impact assessment, MEs, healthcare, healthcare safety, and healthcare checklists. There is a need for more in-depth research to understand risks and strengthen safety protocols. This can be achieved by tailoring practices to the specific features of LMICs. Investment is overdue to understand the risks, build systems and strengthen communication during a safety paradigm shift. The research team focuses on tailoring healthcare systems to optimize safety and quality while minimizing MEs to design a safety and quality reporting system.

Keywords: health impact assessment, medication errors, healthcare, safety, checklist

Introduction

Medication Errors (MEs) are injuries due to a failure in the treatment process that occurs from the 'womb to the tomb' [1]. There are errors and their consequences in world health care, including in developed countries, at the intersections of the treatment process, i.e., from prescriptions issued to the drugs dispensed and the medications taken by patients [2]. According to the National Coordinating Council for Medication Error Reporting and Prevention (NCCMERP) definition, a medication

error is any preventable event that may cause or lead to inappropriate medication use or patient harm while the medication is in the control of the health care professional, patient, or consumer. [3]. Errors can result from human factors, communication breakdowns, and ineffective systems. They can occur at all steps of the production, distribution, and monitoring of a drug within a defined segment of the downstream process [4]. In the world, inadequate and unsafe patient care has emerged as one of the top ten causes of disability and death. In the United States of America, there are more than 100,000 preventable adverse events that lead to death in hospitals, more than deaths due to road traffic injuries, and it has an added cost of 50 billion dollars to the health care system and lost productivity due to disability. Of all the adverse events, more than 50% is preventable. Of this, 50% is due to the medications. [5]. There are no records of MEs from Low- and Middle-Income Countries (LMICs) or the eastern and north-eastern parts of India, as noted by our inter-professional research group. The intricate dynamics of the healthcare system have additional repercussions on the community that go beyond the injury of the individual concerned. To develop strategies to anticipate and address gaps, we need to focus on ways to combat activism and raise awareness of patient safety risks. There is a need for a systematic approach to understanding the shifting paradigm in ethical, legislative, and societal interventions regarding the integration of the system. Our team developed and defined a conceptual and contextual framework for the MEs and their impacts, with tailored strategies to prevent and safeguard patient safety through training healthcare staff in a multitier approach that included inter-professional communication.

Methods

The present systematic review adhered to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines.

Eligibility criteria

Inclusion criteria permitted literature on the definition, classification, and categorization of MEs, including quantity assessment, record evaluation, safety paradigms, and viewpoints, from prospective and retrospective studies published in English. We excluded articles on non-MEs and us being resource-constrained, we also excluded articles behind paywalls. Studies were grouped by synthesis according to the primary outcome variables of basic components of MEs, viz., risk factors, hazards, complications, interventions, capacity building, research and development on protocols and checklists, digitalization, and ethics.

Information sources

Our retrospective data mining strategy made efforts to explore all information resources both from physical libraries and online digital databases. Bibliographic searches spanned 1995 to January 2025, incorporating reliable sources, viz. Google Scholar, ResearchGate, PubMed, SCOPUS etc. Documents in the public domain from sources such as blogs, databases, registers, websites of organizations or specific topics, submission data, press and media news, survey databases, and news information were also accessed. Reference lists from potentially eligible studies that contained relevant information were explored.

Search strategy

The search strategy employed Medical Subject Headings words and invariably Boolean operators: (\"Medication\" [all fields] OR \"Error\" [all fields]

AND (\"Safety\" [all fields]) OR \"Outcome\" OR \"Adverse events\" OR \"Impact\" OR \"Complications) AND Checklist.

Selection process

Following a systematic and comprehensive database search, a total of 102 articles were identified, primarily from PubMed, Google Scholar, Research Gate, and SCOPUS, along with additional studies retrieved from reference lists. After removing duplicates, 89 articles appeared potentially relevant based on their titles and abstracts. Full-text screening resulted in 48 articles meeting the eligibility criteria, while the full texts of 21 articles could not be accessed. Ultimately, 20 studies were included in the systematic review table, and 28 additional articles were used to support the discussion (Figure 1).

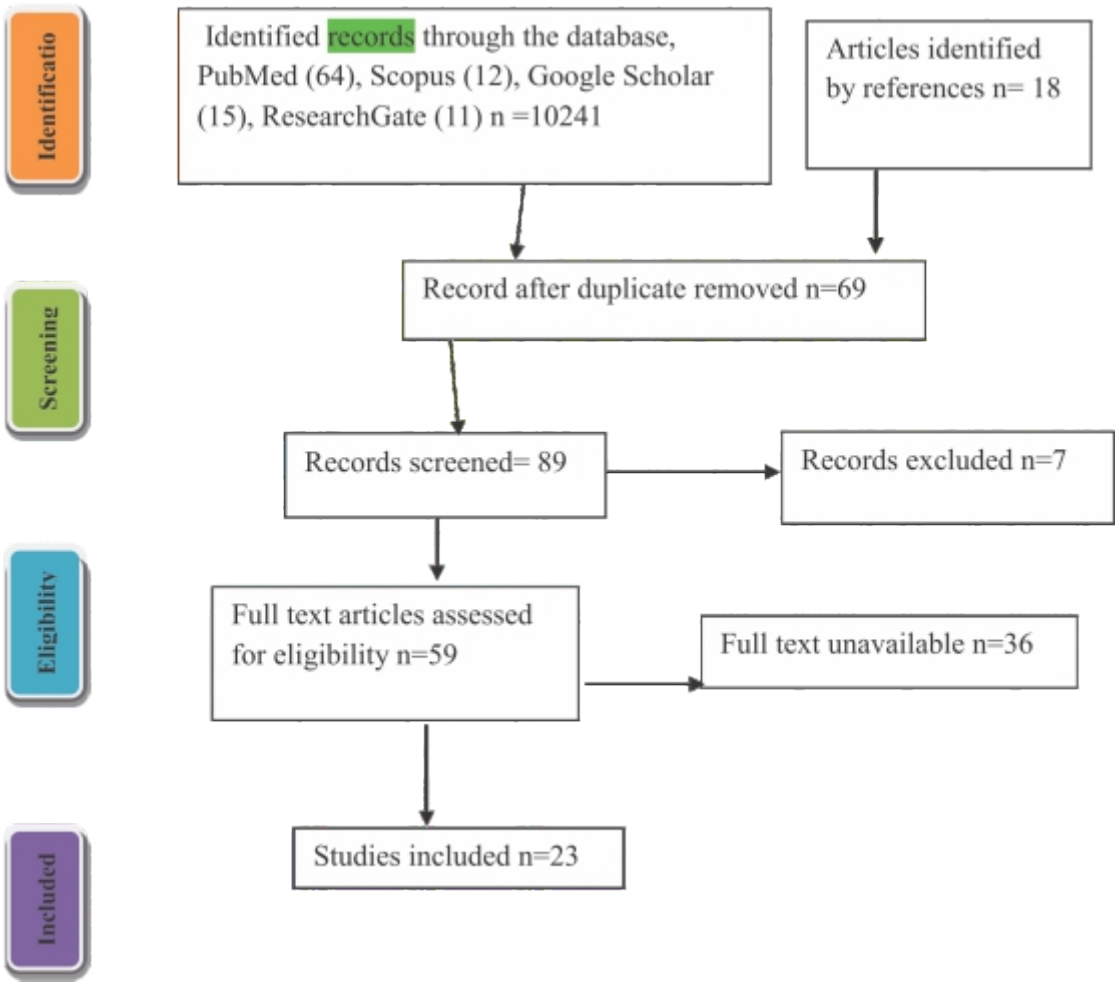

Figure 1: Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) diagram

Data collection process

Each full-text article was thoroughly reviewed by at least two investigators to assess its suitability based on the inclusion and exclusion criteria, with particular emphasis on the quality of the studies rather than the quantity, in order to minimize ambiguity.

Data items

The first data item to be defined from the systematic review conducted by our inter-professional research group involved framing the first thematic search question as 'What extent of harm do patients and the health system incur from the occurrence of MEs?'

Study risk of bias assessment

The bias of the study was assessed using the National Heart, Lung, and Blood Institute (NHL BI) quality assessment tools.

Effect measures

All the reviewers studied and assessed the literature independently and later worked in groups for each outcome variable in data abstraction and analysis, viz. epidemiology, interventions, capacity building, research and development for concurrence.

Synthesis methods

Data extraction and synthesis were conducted from studies that met the recommended eligibility criteria. The following information was extracted: publication year, publication title, authors, type of clinical instrument, variables, duration, and main findings. Systematic search for information, viz., literature support and full-text review, was done using the strategy to search by agreement, relying on bibliographic citations, namely 62 journal publications, 18 books and booklets, 22 websites for this analysis, limiting the chance of bias.

Reporting bias assessment

The quality of all included studies was evaluated using dedicated checklists, viz. Quality Assessment Tool for Observational Cohort Studies, Controlled Intervention Studies, and Reviews. Extra care was taken to exclude grey literature, viz., information published in conference proceedings, unpublished theses, and literature from unreliable data sources or documentation, and abstracts or PowerPoint slides of research presented at important national and international conferences, with evidence presentation/guest lecture/experience sharing /communication in scientific forums. To minimize publication bias, we limited our review to the highest-quality, most trustworthy data sources, viz. PubMed, SCOPUS, Google Scholar, and Research Gate. Based on our inclusion criteria, we collated data on MEs from peer-reviewed, indexed journals published by reputable academic publishers. The NHLBI checklist utilized to find bias for our literature is annexed: Good: 2, 4, 6, 7, 8, 9, 10, 12, 14, 15, 17, 18, 2519, 20, 21, 22; Fair: 11, 13, 23; Poor: 16 [Annexure 1].

Certainty assessment

To ensure the highest-quality review of an outcome, we limited the search to high-quality peer-reviewed journals from reputed publishers with high-quality literature hosted on conventional, trustworthy data sources, like PubMed, SCOPUS, Google Scholar, and ResearchGate.

Results

Study selection

Following the inclusion criteria, 20 studies were analyzed. The results of the search and selection process, from the number of records identified in the search to the number of studies included in the review, are described using a flow diagram that

outlines studies that met the inclusion criteria but were excluded, along with the rationale for their exclusion [Figure 1].

Study characteristics

Our review on MEs included challenges to innovate strategies and tactics to mitigate errors, capacity building of healthcare providers, and barriers to implementation from reviews (n = 16), cohort studies (n = 2), randomized controlled trial (n = 1), and editorial (n = 1).

Risk of bias in studies

Risk of bias for each included study is described in the Methods section [Appendix 1, Supplemental material].

Results of individual studies

Our study outlined the extent, nature, and consequences of MEs in the contexts of the time, place, and person distribution of the medication-related hazards and complications, interventions applied, capacity building to limit human error, research and developments on protocols, checklists, digitalization, and ethical considerations, among other broad issues.

Results of syntheses

Epidemiology

MEs are major global public health problems adding financial burden to communities; millions die each year, more than from road traffic and occupational hazards, breast cancer, or HIV, yet this gets less public attention [6].

MEs occur in a) production – incorrect strength, flawed or deceptive package, adding contaminants or adulterants, b) medicine selection - illogical, improper, useless, under- or over-prescribing, c) monitoring – not altering or optimizing intervention, d) writing prescriptions- inapt or illegible, e) dispensing- incorrect molecules, formulation, label, f) administration- incorrect dose, route, frequency, duration [7]; mostly during medication administration [2]. MEs are mainly caused by cognitive overload, fatigue, and poor training. Working under stressful conditions increases the risk of mistakes among healthcare workers [8]. Fatigue from circadian rhythm disruption from shift work, overtime, extended working hours, and sleep deprivation contributes to administrative errors [9]. Effective communication and a team approach are vital for safe patient care [10]. Estimated extra costs from the brunt of drug-related injuries amount to 3.5 billion dollars per year, with additional loss of wages and productivity and out-of-pocket expenditure [11]. A research group estimated annual global morbidity and mortality costs of MEs to be 77 billion dollars [12].

Workload was identified as a risk factor for errors, and increasing workload for medical practitioners increased hospital or clinical department costs [13]. Unfamiliar tasks with critical thinking were liable to MEs, viz., dosage and dilution in very young or old patients, intensive care unit, intravenous drugs, antiplatelet agents, diuretics, NSAIDs, and other 'preventable admissions' drugs [4]. Of the MEs in primary and ambulatory settings (4 in 10 cases), 80% are preventable and a 15% reduction is possible by involving patients in their own safety [14]. There can also be psychologically classified errors as knowledge, rule, action, and memory-based errors [15].

Interventions

Mitigation of MEs starts with error categorization as a central landmark decision of paramount importance, as the error probabilities of different classes vary and are addressed with an array of

dedicated remedies [1]. For optimal intervention, we need to classify and differentiate errors, flag common ones to develop mitigation strategies, and curtail prescription and administration errors. Communication and collaboration within an inter-professional team ensure precision and reconciliation, thereby limiting hazards [2]. We need to improve the design of healthcare systems by implementing standardized processes and updated infrastructure to minimize MEs through systemic change and feedback within organizations, with inbuilt checks and balances [6]. Two approaches can address the problem of human fallibility: a. person-centric approaches focus on individuals and poor memory, distraction, or moral flaws; b. System approaches focus on changing work environments and building checks and balances to mitigate lapses. Under the vicarious liability the responsible organizations plan to streamline human variability by capacity building constantly preoccupied with probabilities of crash [8].

Researchers proposed reducing fatigue among nurses to diminish cognitive performance loss due to reduced attention and alertness, thereby reducing the risk of faults and hazards. However, the evidence showed heterogeneity in quantifying and linking fatigue to administrative errors [9]. Experts on ME strongly recommend education, compliance, and literacy for both healthcare providers and patients in the OPD and community [12]. Research groups feel that half of the medication hazards can be reduced with our focused intervention on primary and ambulatory care, with decreased need for hospital care for investigations and management; the Organisation for Economic Co-operation and Development (OECD) estimates this as 2.5% for the health exchequer, 6% of bed occupancy, and 7 million admissions per annum [14]. Error reporting has to be encouraged by creating a non-threatening working environment for faults ranging from trivial to serious. A 'nip in the bud' outlook within the limits of confounding amid a rational therapeutic decision regimen is recommended to balance beneficence and non-maleficence in pharmacokinetics and pharmacodynamics to go with pathogenesis [15] perfectly.

Capacity building

In clinical practice, research suggests that capacity-building is needed to cope with the fatigue inherent to various healthcare work schedules, such as night duty, overtime, and shifts, while performing cognitively demanding tasks [9]. There is a prevailing discourse that staff shortages are a key reason for poor-quality primary care in LMICs, and that the origins likely lie elsewhere, ranging from willingness to inability, motivation to efficiency, and beyond [13]. Research groups noted higher rates of MEs in inexperienced, inattentive, rushed, distracted, fatigued, or depressed health-care workers, viz., nurses under stress or freshers. Computerization and digitalization effectively reduce rates and may enhance safety, even against rare and hazardous errors [4]. Training and retraining in effective communication, along with professionalism across the healthcare team, can ensure the correct administration of medications. The inherent limitations of manpower-centric service delivery constrain success in complex medical care. It is critically essential to innovate and develop tools within the healthcare environment to enable everyone to share concerns using 'critical language' to uphold safety [10]. The common belief that poor-quality primary care in LMICs is associated with a manpower shortage amid excessive workload was

unfounded in the study of Senegal; expertise and motivation may play a role [13]. Caregivers should be sensitized to ethical care and to adherence to the philosophy of "First, do no harm" (primum non nocere) in a patient-friendly milieu, and consistently focus on upgradation to optimize healthcare outcomes [16].

Research and development

Stakeholders should find an optimum mix of strategy and tactics for the safety of staff and patients while optimizing working hour needs and fatigue management to re-evaluate systems to ensure safety and quality of care [9]. A research group working on 'managed care pharmacy' suggested reducing iatrogenic issues by spreading information and educating both caregivers and care-seekers about ME-reduction activities to optimize patient safety [12]. Studies in Senegal showed that even at times when workload is high, there is no evidence that provider effort or quality of care are significantly reduced, indicating that providers operate below their production possibility frontier and have sufficient capacity to attend to more patients without compromising quality, which contradicts conventional ideas of capacity building [13]. Studies on electronic prescribing systems, bar coding by 'Computerized Physician Order Entry (CPOE)', showed positive results in minimizing errors by providing checks and balances [17]. In the new millennium, the Institute for Safe Medication Practices has prompted analysis to manage MEs by developing and adhering to standardized protocols and guidelines to ensure consistency in medication practices [18]. A research group that holistically studied MEs, including nosocomial infections, falls, and handoff issues, as well as diagnostic and documentation errors, explored their risk factors, risk correlates, and impacts to identify strategies and tactics, with special emphasis on teamwork and a safety culture to limit them [19]. To Err is Human (1999) from The Institute of Medicine ushered in a new era of internalization in US healthcare, radically elevating patient safety to center stage and initiating and sustaining dedicated research funding to mitigate MEs [20]. Multidisciplinary team meetings, clear labeling, and patient education could also enhance communication among team members and minimize associated errors [21]. Medication reconciliation processes spot discrepancies at different transition points and prevent MEs and Adverse Drug Events (ADEs). An Indonesian cohort study identified discrepancies in medication receipt/non-receipt during medication reconciliation [22]. Researchers estimated that in LMICs, 4 in 100 people die from unsafe care; globally 1 in 10 are harmed from hazards during discharge of unsafe healthcare resulting in 3 million deaths and 64 million Disability-Adjusted Life Years (DALYs) per year, comparable to HIV/AIDS; economic growth is reduced by 0.7% a year; indirect cost go up to trillions of US dollars per year [23].

Summary of evidence

Data abstraction and analysis in this review probed the qualitative and quantitative aspects of MEs and their impact on patients in particular and the healthcare system in general. Dedicated precautionary measures, implemented through collaborative inter-professional team efforts, help rid the system of these hazards. MEs result in a plethora of hazards, viz. nosocomial infection, prolonged hospitalization, higher cost, prolonged morbidity with mortality and disabilities, and lingering

impacts beyond patients and their caregivers, providers, institutions, and communities. ME mishaps in LMICs can be mitigated mainly through continuous professional and infrastructural updates. The scalar principle needs to be instilled across stakeholders with a systems approach of real-time feedback information in a threat-free milieu. For success stories in safety implementation, a deeper understanding of why mistakes occur is essential for follow-up and for developing strategies to effectively reduce incident hazards and optimize efficiency, thereby enhancing the financial sustainability of healthcare delivery systems. (Table 1).

Table 1: Literature included in impact of errors in medication on healthcare- A systematic review (n = 23)

Authors and study type	Summary of observations in the study
Tariq *et al.* 2024 [2]	Types, causes, strategies to minimize prescription and administration errors, communicate and collaborate within an inter-professional team to ensure accurate medication reconciliations and minimize ME risk.
McDowell *et al.* 2009 [4]	How errors occur, what factors alter risk; models proposed and reviewed
Kohn *et al.* 2000 [6]	Millions of human tragedy with huge financial loss from ME
Aronson *et al.* 2009 [7]	Identify preventive strategies in medicinal errors, define, classify terms. Four main approaches to define technical terms consider etymology, usage, previous definitions, and Ramsey-Lewis method
Reason *et al.* 2020 [8]	Approaches to limit human error with models for management.
Bell *et al.* 2023 [9]	Multidimensional fatigue impacts nurses' work during drug administration
Leonard *et al.* 2004 [10]	Effective communication plays a crucial role in reducing iatrogenesis.
Aspden *et al.* 2007 [11]	Joint report of the National Research Council jointly with the National Academy of Sciences, National Academy of Engineering, and the Institute of Medicine
Grissinger *et al.* 2003 [12]	Suggested educational programs for patients, managed care, and community pharmacists to reduce MEs in OPD and the community.

Continued...

Kovacs *et al.* 2022 [13]	Staff shortages may not be the key reason for poor quality primary care in LMICs and origins - likely paradigms exist elsewhere.
Auraaen *et al.* 2018 [14]	Organization for Economic Co-operation and Development working paper on economics of patient safety in primary and ambulatory care
Aronson *et al.* 2009 [15]	MEs definition, how they happen, how to avoid them
Herndon *et al.* 2013 [16]	The patient first. Above all do no harm (primum non nocere).
Bates *et al.* 1998 [17]	Efficacy of 2 interventions to prevent non-intercepted serious MEs from resulting or potentially occurring before reaching patients.
ISMP Canada 2000 [18]	Medication Safety Alert! June 2000.
Pham 2012 [19]	Medical error, adverse event and near-miss errors discussed
Bates *et al.* 2018 [20]	Assessment of progress and emerging priorities in patient safety
O'Daniel *et al.* 2008 [21]	Professional communication and team collaboration affects several interfaces and patient handoffs among multiple healthcare personnel.
Sholihat *et al.* 2018 [22]	The medication reconciliation system identifies drug discrepancies at different points of transition to prevent MEs and adverse drug events.
Slawomirski *et al.* 2022 [23]	OECD strategic background report for patient safety priority within the 2020 G20 Health Working Group, commissioned by the Saudi Government.

Reporting biases

Based on the universally accepted criteria of the analytic framework of NHLBI identifying good quality of the published literature used in this systematic review was as follows Good: 2, 4, 6, 7, 8, 9, 10, 12, 14, 15, 17, 18, 19, 20, 21, 22, Fair: 11, 13, 23, Poor: 16 (Annexure 1)

Certainty of evidence

Our inter-professional research group excluded information that was not published in clearly comprehensible databases or journals with reputable indexing or in suspected predatory journals.

Discussion

Our inter-professional research group recognized the need for a methodical assessment to identify paradigm shifts in ethical, legislative, and social approaches to holistic health care interventions.

This systematic review weighed evidence from literature sources to identify errors before, during, and after intended interventions, viz., frequency, types, risk factors, and outcomes, across publications involving diverse healthcare disciplines and settings. Our data showed that skill, judgment and teamwork improved quality and safety for better outcomes by dedicated strategy and tactics. We identified emerging issues arising from the transition from manual to digital, such as e-prescribing, and addressed them as they occurred during the hospital's transformation period. The NCCMERP defined MEs as avoidable cases of inappropriate medication that pose hazards to care-seekers from health providers, related to professional issues, products, procedures, and systems encompassing prescription, communication, labeling, packaging, and taxonomy, through compounding, dispensing, distribution, administration, education, monitoring, and use [24].

Indian studies on medication related errors and efforts to minimize them

Safety in healthcare should be on the national agenda for Higher-Income Countries (HICs) and LMICs such as India, in response to research highlighting poor quality in media reporting [25]. An Indian research group felt that standardization, clinical decision support systems, interdisciplinary alliance, and professional updating can reduce MEs [26]. A review from Punjab concluded that prescribing errors are the leading cause (67%), followed by administration (25%) and dispensing (8%), with downstream hazards or unwelcome therapeutics [27]. A review from Rajasthan noted MEs from a lack of professional excellence of providers to a deficiency of quality of products, procedures, and systems, and suggested the creation of a non-threatening environment to monitor, identify, assess, and analyze root causes to ameliorate and report as a team in a scalar approach [28]. The prescription audit on elderly patients, using Beers' criteria 2002, at an OPD in Gujarat noted overall 7.42% and 23.59% partial prescription errors; mostly inappropriately for antihistamines, anticholinergics, sedatives, hypnotics, and cardiac glycosides [29]. Types and severity of adverse potential Drug-Drug Interaction (pDDI) in a medicine OPD of Gujarat noted pDDI prevalence as 83.42%; aspirin was the most prescribed (48.16%) typically with metoprolol (6.09%). Interactions were pharmacokinetic (26.76%), pharmacodynamic (68.92%); serious (3.67%), significant (73.37%), and minor (22.94%); age and number of drugs prescribed correlated highly significantly with drug interactions. Use of electronic decision support tools, continuing education, and vigilance minimizes pDDIs [30]. Inappropriate prescriptions were more in the elderly from inpatient departments and OPD using Beers and Phadke's criteria. MEs were found to be rational (39.5%), semi-rational (32.3%), and irrational (28.3%) [31]. An interventional study from Puducherry that evaluated the impact of sensitization and blame-free ME showed reduced error rates in intensive care units of cardiology, medicine, pediatrics and neonatology. Prescription order review and direct observation of administration of medication reduced prescription errors from 9.1% to 3.5%; however, reporting did not improve despite the use of blame-free reporting tools [32]. In a study from Pune, incidences and risk outcomes were assessed in the critical care unit by medication chart review; MEs were 6.11%; the commonest were transcription (44.1%), prescription (40%), administration (14%); incomplete prescription (50.2%), and wrong dose (22.9%), involving antibiotics and antihypertensive

agents. Notably, 87.1% MEs were in Category B of the NCCMERP risk index. Clinical pharmacists may act as checkpoints at each step to identify and stall MEs [33]. They may play a proactive role in liaising with prescribers to sensitize patients to unexpected symptoms arising from possible adverse effects of drug therapy [34]. A study from Kolkata explored types, factors, and steps to reduce MEs through root-cause analysis of all reported instances; and noted gross under-reporting (0.0017%); administration errors accounted for 69.3%, with male patients predominating (53.1%) [35]. Previously published systematic reviews reported major MEs in 6.5% of hospital admissions in HICs, as reported by professionals at different levels and points in time, prompting regulatory bodies to suggest checklists and guidelines to reduce the hazards [2]. To combat MEs we need multi-pronged approaches inbuilt with preventive strategies ranging from defining technical terms in etymology, usage, definitions to real-life situations that have potential to harm the patient. 'Balanced prescribing' excludes prescribing faults: wrong prescription writing includes wrong instruction regarding identification of recipient, drug, formulation, dose, route, timing, frequency, and duration of administration as well as psychological mistakes from knowledge-based, rule-based, action-based and memory-based lapses [7].

Omission is difficult to prove in societal, ethical or legal parlance

Medication errors in HICs are a significant concern in primary care; in LMICs like India, they are notional and undervalued. A UK-based systematic review of 1108 population-representative studies involving 141 million adults found that, mostly in LMICs, diabetes treatment was not aligned with the rising prevalence. The actual spread of awareness of the implications of microvascular and macro-vascular complications across all organ systems, through the alignment and integration of universal health care, can enhance early detection and effective intervention. [36]. To sum up, our inter-professional research group delineated the conceptual and contextual framework of MEs and their consequences, with dedicated mitigation approaches to champion patient safety through capacity-building of healthcare personnel through multi-pronged means, including interpersonal communication. Our study emphasizes that the definition, classification, and categorization of MEs should be standardized and rationalized to streamline efficacy, effectiveness, and safety in all phases of intervention. Medication errors pose risks to patients, thereby straining resources and increasing morbidity, mortality, and the cost of care. The findings call for an all-inclusive approach, including, among others, improvements in health practitioners' training, robust prescription-handling systems, and the encouragement of a safety-conscious environment in health facilities such as hospitals. Additionally, the report suggests that despite improvement in identification and resolution of drug-related mistakes, there are still significant gaps in reporting mechanisms, standardization, and use of technology, among others. Attention should be directed to these areas of improvement to reduce ME, thereby relieving pressure on health care systems. Mitigation policies were weighed to reduce errors, and actions were optimized to improve safety and quality by using safety checklists to decrease adverse events and costs. The strengths of this review are that it aimed to identify common types and causes of medication-related errors, quantify their prevalence, and provide evidence of their significant and diverse effects on outcomes and healthcare costs across

healthcare systems. The review collated current initiatives aimed at ensuring optimal medical intervention and the provision of safer health services. Significant improvements in outcomes can be achieved by scrutinizing the entire care continuum, as most errors occur outside the hospital environment. An all-inclusive review was conducted of the challenges that accompany care, with special attention to the strengths in reporting and analysis of complications to promote the best outcomes and make comparative studies easier. Both physical libraries and cyberspace were accessed to gather as many sources as possible, in good faith, to consolidate our responsibility for safety issues in the healthcare arena.

Conclusion

Iatrogenic hazards can be averted by internalization of multipronged approaches to healthcare safety and ethical communication, by proactively avoiding harm, and by sensitizing personnel for unflinching adherence to 'safety first' principles. We propose a systems approach to document the distribution and determinants of errors, with timely disclosure. Stakeholders at all levels, with a positive mindset, can be sensitized to mitigating errors through capacity building and the framing of clinical practice checklists embedded in infrastructural changes aligned with recent advances in science and technology.

Limitations of review process and evidence included in the review

First, our inter-professional research group identified only 20 relevant studies that reported medical adverse events and complications, interventions applied, capacity-building to limit human error, and ongoing research. Second, the studies did not cover medicinal errors from around the world, as defined by the study criteria. Third, in the absence of universally accepted protocols for error reporting, there were discrepancies in classifying incidents as publishable adverse events. Finally, the results included in this review showed heterogeneity in their definitions of mistake and error.

Implications of results for practice, policy and future research

Given the information from the evaluated 22 studies, the potential for the healthcare system's improvement, through the implementation of practical measures aimed at mitigating the risks involved in the system, enhancing patient safety and improving the outcomes, are numerous. Healthcare training and education systems must also focus on the inclusion of clinical decision-making, competency-based education and training through simulation, and the military-style rehearsal of safe practice checklists enhanced through teamwork, communication, and compliance with the use of control measures aimed at preventing error and systemic failures. Error prevention systems should be designed, and the healthcare system should be improved to be easily adaptable and to have real-time feedback and monitoring aimed to reduce the burden of the healthcare system to have simulation-based training to improve the technical and teamwork of the healthcare system users to reduce the burden of the system and to reduce the healthcare system's driven complications. There have to be systems designed and implemented to improve communication between patients and healthcare providers. The system is progressing economically through the development of standardized evaluation systems for MEs. There is a focus on interdisciplinary and multidisciplinary training

and education aimed at the management of complex interrelated systems in order to include the biological and social systems of healing. The special conditions of the LMIC and tropical countries should not be a deterrent to provide the audience with practical guidelines for the present important reduction of technological and industrial risk. This research examines the connection between patient harm incurred through errors made compared to the total cost attributed to inefficiencies through the lens of several recent studies to determine what changes are needed to improve protocols, staff updating, and the implementation of stronger monitoring systems to improve the safety and quality of services provided.

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