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SYSTEMATIC REVIEW

Impact Analysis of Diagnostic Errors on Healthcare Delivery: A Systematic Review

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Abstract

Background: There is need to collate the evidences on the prevalence of diagnostic errors and their influence on hazardous outcomes to affect efficiency, cost and safety in healthcare delivery. **Objectives**: This review addressed diagnostic errors in terms of epidemiology, hazards, impacts, challenges to suggest holistic recommendations to all the stakeholders, researchers and administrators. **Methods**: Electronic public domains viz. PubMed, SCOPUS, GoogleScholar, ResearchGate. and manual search on diagnostic errors and interventions implemented by clinician in clinical environment, searched for literatures published between January 2005 and June 2025 for common errors concerning the diagnosis in the practice directed towards the patient, direct and indirect repercussions on health and financial and operational aspects of healthcare, challenges, research and interventions to improve patient safety by checklists using PRISMA reporting guidelines. **Results**: A total of 291 articles were screened of which 28 studies met inclusion criteria of our review. Data extraction was done by two groups, each group comprising two independent investigators from Review (n=20), Cohort study (n=2), Cross-sectional, (n=3), Controlled intervention (n=2), Invited Commentary (n=1). WHO check list, digitalization and AI are showing potential solution for error reduction amid ethical, legal, quality assurance issues. **Conclusions**: Our analyses revealed evidence on prevalence, risk correlates and interventions to limit DEs being feasible in clinical settings across High Income Countries (HICs) and Low and Middle Income Countries (LMICs). A comprehensive approach is needed to ensure safety by quality of care at every patient interface, capacity building and systems approach to enhance accuracy and ensure updating.

Keywords: Diagnostic error, impact, healthcare, patient safety, remedial measures

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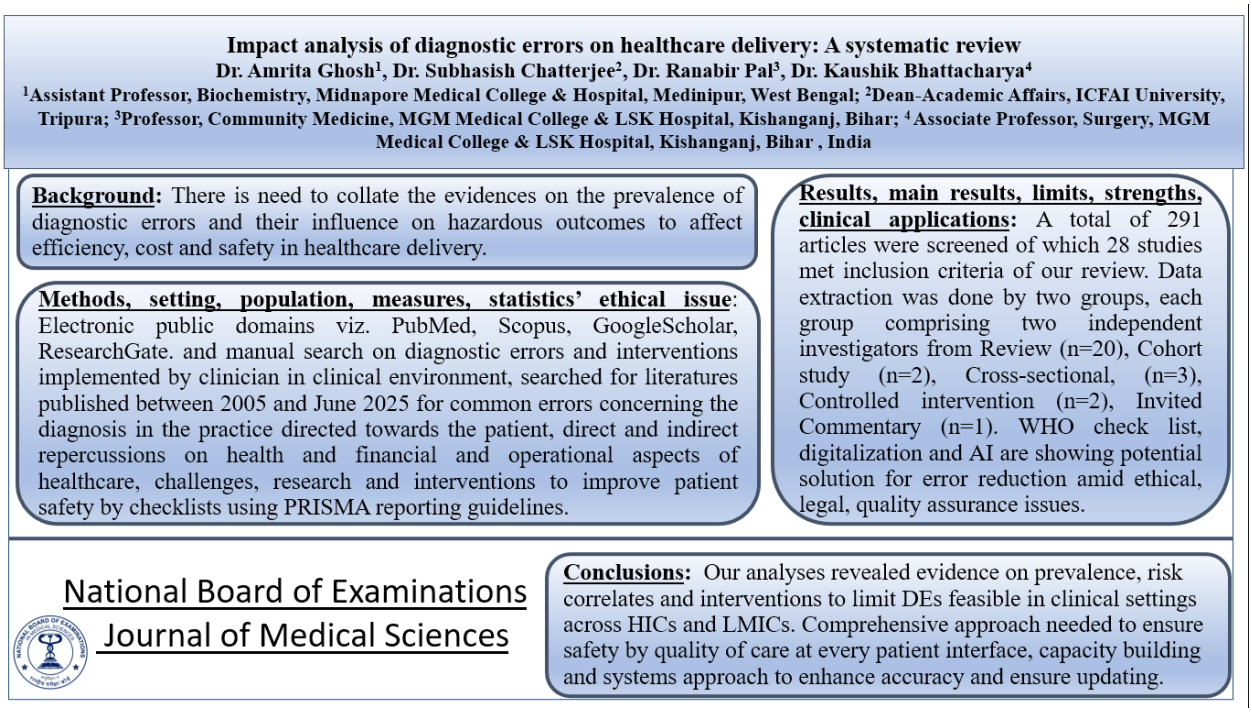
Graphical Abstract



Introduction

WHO promulgated "First, do no harm" is the key principle of health care. Across geographical or temporal boundaries in evolving junctures of paramount importance on diagnostic errors (DEs), precise and timely diagnosis is ever more vital milestones supported with prompt interventions to limit hazards amid optimum prognostication [1]. National Academy of Medicine defined DEs as "the failure to (a) establish precise and timely explanation of patient's health issues or (b) share an explanation with the patient" [2]. Healthcare workers (HCW) accept DEs as preventable hazards that endanger patients and ruin invaluable resources at every set up and level of health system to reflect unsafe issue and optimally address at right time and right place [3]. Deficient competencies, technical skills, and cognitive illusions encourage DEs which lead to wrong procedures, longer treatment time or cause lasting injuries. These un-or under-diagnosed pathophysiology add suffering to the care-seekers with delays in treatment initiation, under- or overtreatment, or worsening morbidity and disability with or without mortality [4]. The negative consequences of DEs have placed attention on research on its causes and outcomes. Failures in diagnostic processes adversely affect the safety of patients; also leads to wastage of resources due to increased rates of re-admission, excess length of stay and increased expenses in health care. Such trends of work focus on the relevant education of healthcare professionals as a measure of control, adoption of various more effective diagnostic techniques, and the need of digitalization [5]. DEs are failure to do & communicate precise and apt clarification of

health matter to the care seekers [6]. The rationale for this review lies in the context to sensitize on upgrading knowledge solving issues as pivotal to mitigate hazards and enhance safety in health care dimensions limiting diagnostic errors in medicine viz. Epidemiology, Hazards, Impact, Interventions, Researcher and Challenges to suggest best current measures.

Methods

Eligibility Criteria

Inclusion Criteria: Studies published in English peer reviewed journals related to DEs (i.e. error type: undiagnosed, wrong diagnosis, late diagnosis), Studies investigating the effects of DEs on healthcare outcome (e.g. mortality, morbidity, hospitalization rates, duration of stay), focus on economic/resource impact (e.g. additional costs, excess tests, waiting time for treatment); qualitative and quantitative research: (cohort, case-control, cross-sectional and interventional studies) and reviews. Exclusion Criteria: Literatures on other issues excluding errors, not in English language, conference and grey literatures.

Information Sources

This review put effort to find information from offline and online databases. Bibliographic search and consultation were initiated since 2005 from dependable sources from public domain viz. PubMed, SCOPUS, GoogleScholar, ResearchGate and others viz. databases, registers, websites, media, and news portals. Reference lists from potentially eligible studies that contained relevant information were explored.

Search Strategy

MeSH search terms and Boolean operators were used: “Diagnosis” [all fields]). Search strategy was constructed using Medical Subject Heading terms combined with Boolean operators: (“Diagnosis” [all fields] OR “Errors” [all fields] AND (“Hazards” [all fields]) OR “Outcomes” OR “Adverse events” OR “Impacts” OR “Complications) AND “Checklists.” 291 articles were screened of which 28 studies met inclusion criteria of this systematic review.

Selection Process

Following a methodical search through databases, 178 literatures were identified and 113 from articles in the list of references. After duplication check 146 records were removed; 145 were considered potentially eligible based on the title or abstract, both title and abstract. After full-text review, 28 studies were eligible as 117 full texts were unavailable; summary table included 21 literatures; 7 enriched manuscript (Figure 1, Table 1).

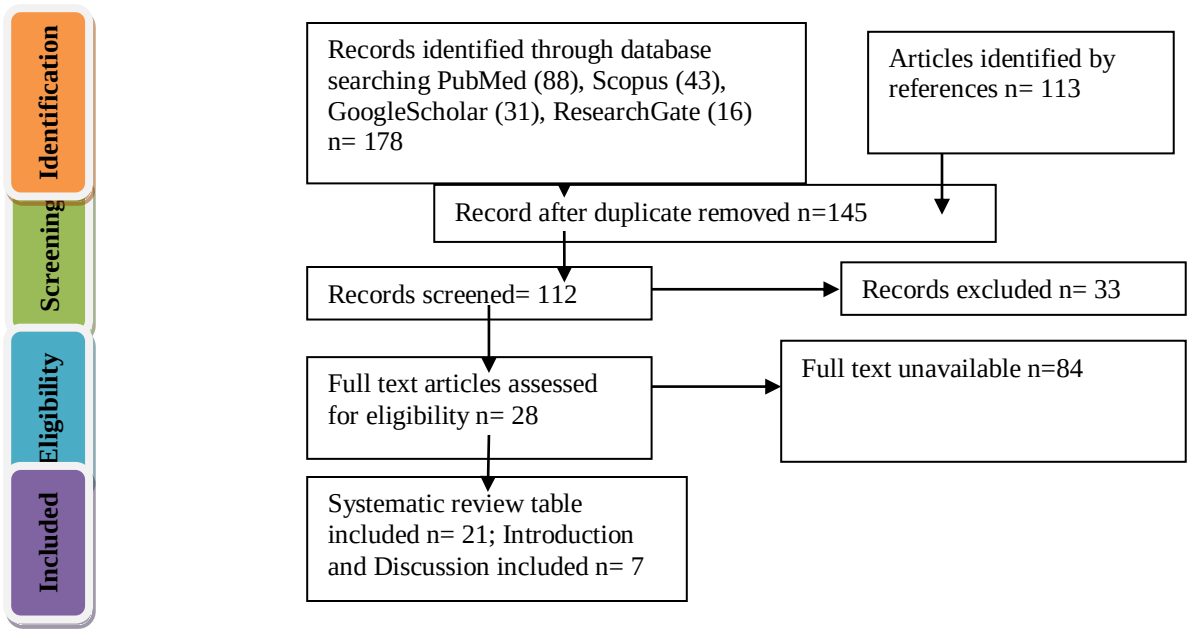


Figure 1. Impact of diagnostic errors on the healthcare delivery: A systematic review- Preferred reporting items for systematic reviews and meta-analyses (PRISMA) diagram

Table 1. Literature included in 'Impact analysis of diagnostic errors on healthcare delivery: A systematic review' (n =21)

Authors and Type of study	**Salient findings in the study**
Betsy Lehman Center for Patient Safety Annual Report (2024) [6].	Factors of DEs: System-level factors, Cognitive bias, Incomplete/inaccurate patient information, Limited time with patient, Patient factor
Auerbach AD et al (2024) Multicenter retrospective cohort study by EHRs (2023-2024) [7].	High rates of DEs among critically ill adult ICU transfer & in-hospital deaths; imply targetted interventions within hospital settings transferred to ICU or who died with harmful & underlying causes to design future intervention
White Paper on human & financial loss of DEs (2016) [8].	Abridge data of 2.5 lacs indoor US cases; all with lifetime incident; loss of million labor days, demise upto 80,000 and U.S. $750 billion each year.
Invited Commentary on DEs in primary care (2013) [9].	Focus on measurement & classification with individualized intervention of causative factors of DEs viz. issues of cognition, communication, resources, priority in preventing DEs in primary care settings.
Graber et al. Review on intervention to reduce DEs (2012) [10].	Cognitive interventions to reduce diagnostic error: a narrative review.

Singh H et al DEs in primary care levels (2013) [11].	Frequency DEs in clinical conditions process breakdowns, contributory factors, and harm; compared patient and practitioner variables in primary care visits with and without errors; patient characteristics as proportions.
WHO Patient safety. Key facts. 2023 [12].	Document discussed on DEs on salient facts, common sources and factors, System approach to patient safety, "Global action on patient safety", "Global Patient Safety Action Plan 2021–2030", "World Patient Safety Day", WHO Flagship initiative "A Decade of Patient Safety 2021–2030"
Cheraghi-Sohi et al Cohort study 2021 [13].	DEs were <5% among primary care consultations, extrapolated nationally is millions potentially at risk of avoidable harm by multifactorial risk yearly; need to develop & evaluate multipronged intervention with policy changes.
Singh et al. Review 2014 [14].	Impact of DEs on Primary and domiciliary care in USAs was reviewed by yielded a rate of 5.08%, or 12 million US adults every year or 1 in 20
Ely JW, et al. Review Expert consensus 2011 [15].	Implementation of checklists and decision support systems significantly reduced diagnostic errors in clinical settings.
Abimanyi-Ochom et al Review 2019 [16].	26 studies were classified as communication or audit strategies to reduce DEs in clinical settings; technology-based systems (62%) and in acute care setting (57%); limited evidence on interventions being practical.
Berner et al Analytic review 2008 [17].	Study covers scale and impact of DEs correlated to doctor's overconfidence, approach to improve diagnostic precision and scope of futuristic research.
Slawomirski et al 2025 OECD Health Working Papers No. 176 [18].	DEs in chronic cases use 5% of total health exchequer in member countries; 17.5% direct pooled fiscal burden of mis-, under- and over-diagnosis
Newman-Toker et al 2013 [19].	Challenges in DEs are A. Omission: depriving EBM, B. Commission: Quaternary prevention of a. Overuse of b. Misuse of diagnostic tests
NHSRC Diagnostic Safety Review [20]	Study finds DEs in five strata viz. settings and level of care with optimum knowledge; measure diagnostic safety; assess source of hazard; system approach instead of point of care health; updating. Right test and processing of samples are vital mitigation measures to combat DEs from lab medicine.
Graber ML et al Cross-sectional (2005) [21]	DEs are commonly multi-factorial involving system-related and cognitive factors. There is need to develop comprehensive taxonomy to classify DEs.

National Academies of Sciences Engineering & Medicine Literature review: Expert Panel 2015 [22]	'Improving Diagnosis in Health Care': Lesser than 10 years diagnosing treatment frameworks versus period 2010-2015 variables. The article argued that diagnostic training and system improvement could reduce errors.
Materiovigilance Programme of India (MvPI) (2025) [23]	Medical Device Adverse Events database under the National Materiovigilance Programme (MvPI) ADR Monitoring System (ADRMS) report adverse events from medicine, vaccine & medical device.
Choudhury et al. Review (2025) [24]	DEs in India are missed, incorrect, or delayed diagnoses; impact outcome, well-being, quality of life; regarded as No-fault, System, Cognitive errors.
Mishra M et al Review (2017) [25]	Indian research group suggested training of medical students to evade cognitive and system factors that trigger DEs imperceptible to HCWs.
Sharma A. Interview with expert (2020) [26]	DEs can be averted by right technology like boost mobile devices, grow communications, nurture personalized healthcare

Data Collection Process

Each publication was scrupulously and thoroughly scrutinized following our strategy by at least two investigators of our interprofessional research group on the full text screening to guarantee preset inclusion and exclusion criteria with weightage on quality than mere quantity of information to minimize ambiguity.

Data Items

This review has primary thematic search problem as 'How much spells of hazards does the healthcare system imbibe from diagnostic errors in medicine?'

Effect Measures

All the reviewers studied and assessed literatures independently and later on worked together for each outcome variable in data abstraction and analysis viz. What are most often the types of error in the diagnosis directed towards the patient? What are the repercussions of these errors on the health of the patient? What economic impacts do misdiagnoses on the financial and operational aspects of healthcare? How are we tackling to lessen the incident misdiagnoses? What are the unsolved issues and innovative ideas to curtail diagnostic errors?

Synthesis Methods

Data extraction and synthesis was done from the publications that satisfied the recommended eligibility criteria on diagnostic error: year, title, author/s, clinical instrument/s, variable/s, duration, findings. Systematic search for information viz. literature supports, and full-text reviews was conducted using the strategy to search by agreements, relying bibliographic reliable citations, namely - 14 from Journals publications, 7 from web sources.

Reporting Bias Assessment

Risk of bias was assessed using National Heart, Lung, and Blood Institute Study Quality Assessment Tools (NHLBI) (https://www.nhlbi.nih.gov/health-topics/study-quality-assessment-tools) viz. Quality Assessment Tool for Observational Cohort and Cross-sectional, Controlled Intervention Studies and Reviews. Data were sourced from truthful sources of good publishing group and webpages transparent in publication ethics; Good: 6, 7, 8, 9, 10, 12, 14, 15, 17, 18, 19, 20, 21, 22, 26; Fair: 11, 13, 16, 23, 24, 25 (Table 1 and Table 2).

Table 2. Results of quality assessment tool of Cohort, RCT and Review studies included in 'Literature included in 'Impact analysis of diagnostic errors on healthcare delivery: A systematic review' (n =21)

Authors and study type	**Q 1**	**Q 2**	**Q 3**	**Q 4**	**Q 5**	**Q 6**	**Q 7**	**Q 8**	**Q9**	**Q 10**	**Q 11**	**Q 12**	**Q 13**	**Q1 4**
€ Cohort														
Auerbach AD et al (2024).[7]	Yes	Yes	No	Yes	Yes	No	Yes	Yes	Yes	No	Yes	No	Yes	No
Cheraghi-Sohi et al 2021 [13]	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	No	Yes	No	Yes	Yes
€ Cross-sectional														
Singh H et al (2013) [11]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	No	Yes	No
Singh et al Review 2014 [14]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	No	Yes	No
Graber ML et al [2005] [21]	Yes	Yes	No	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	No
₹ Controlled intervention	**Q 1**	**Q 2**	**Q 3**	**Q 4**	**Q 5**	**Q 6**	**Q 7**	**Q 8**	**Q9**	**Q 10**	**Q 11**	**Q 12**	**Q 13**	**Q1 4**
Graber et al. Intervention to reduce DEs (2012) [10]	Yes	Yes	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
Ely JW, et al. Review Expert consensus 2011 [15]	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	No	Yes
ﻯ Review	**Q 1**	**Q 2**	**Q 3**	**Q 4**	**Q 5**	**Q 6**	**Q 7**	**Q 8**						

Betsy Lehman Center for Patient Safety Annual Report (2024) [6]	Yes	NA	NA	NA	NA	NA	NA	NA						
White paper (2016) [8]	Yes	Yes	No	No	Yes	Yes	Yes	Yes						
Newman-Toker DE Invited commentary (2015) [9]	Yes	Yes	No	No	No	Yes	No	NA						
WHO Patient safety. Key facts. 2023 [12]	Yes	NA	NA	NA	NA	NA	NA	NA						
Abimanyi-Ochom J et al Review 2019 [16]	Yes	Yes	No	No	Yes	Yes	Yes	Yes						
Berner et al Analytic review 2008 [17]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes						
Slawomirski et al 2025 Working Papers [18]	Yes	Yes	No	No	Yes	Yes	Yes	Yes						
Newman-Toker et al 2013 [19]	Yes	Yes	No	No	Yes	Yes	Yes	Yes						
NHSRC Diagnostic Safety Review [20]	Yes	NA	Yes	NA	NA	Yes	NA	NA						
National Academies of Sciences	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes						

Engineering & Medicine Literature review: Expert Panel 2015 [22]														
Materiovigilance Programme of India (MvPI). [2025] [23]	Yes	NA	No	NA	NA	Yes	NA	NA						
Choudhury R et al. Review [2025] [24]	Yes	No	Yes	No	Yes	Yes	No	Yes						
Mishra M et al Review [2017] [25]	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes						
Sharma A. Review based on Interview [2020] [26]	Yes	NA	NA	NA	NA	NA	NA	NA						

Main Outcomes and Measures

Epidemiology, Hazards of outcomes, Economic Impact, Interventions and Challenges of diagnostic errors in medicine.

Certainty of Evidence

To establish the highest quality of review, we limited search from high quality peer reviewed indexed journals from legendary publishing houses who bring out literature after being certain of the quality of evidence available in the public domain freely; we are content on conventional trustworthy data sources viz. PubMed, SCOPUS, GoogleScholar, ResearchGate. Most of the documents within this review focus on DEs: their types, causes and consequences on the patients, effects on the economy of healthcare system and policy in general.

Ethical Considerations

Because this is a systematic review of previously published literature, no ethical approval was sought.

Databases Searched

Databases including PubMed, SCOPUS, GoogleScholar, ResearchGate were searched also manually looking through the reference list of the articles.

Search Strategy

The systematic review was conducted in compliance with the PRISMA guidelines. Additional resources viz. reference list of studies included in our review, which aimed at seeking additional papers, as well as databases, were also searched for. In addition, the following gestalt has been formulated so as to provide a method for searching literature using Medical Subject Heading terms incorporated with Boolean features: "Diagnostic" [all fields]).

Data Extraction

The research was organized based on common information gathering forms prepared for each included work, namely: Year, Title, Research group, Study Instruments, Variables, Time Period, and Salient Observations. Our interprofessional research group attempted to classify diagnostic errors in five broad headings viz. Epidemiology, Hazards of outcomes, Economic Impact, Interventions and Challenges of diagnostic errors in medicine.

Results

Data abstraction and analysis

Our interprofessional research team classified DEs on magnitude, underlying causes and associated harms to suggest holistic remedies in five broad headings viz. Epidemiology, Hazards of outcomes, Economic Impact, Interventions and Challenges of diagnostic errors in medicine.

Study Characteristics

Our study analyzed DEs in medicine from Review (n=20), Cohort study (n=2), Cross-sectional, (n=3), Controlled intervention (n=2), Commentary (n=1).

Results of Individual Studies

Our study outlined extent, character and consequences of hazards of DEs in medicine in time, place and person distribution, interventions, research and developments on protocols, checklist, digitalization, ethical issues and challenges.

Results of Syntheses

Diagnosis is not a one-point decision. Rather it evolutes over days and weeks in a process of initiation and continuation of ideas over development of symptoms and signs. Based on initial assessment by clinical acumen, the treating healthcare team providers kick-off 'Provisional diagnoses' and initial interventions. These are corroborated by supporting highly structured battery of laboratory medicine and imaging studies when 'Final diagnosis' is reached amid prognostication. Further, in the capricious pathogenesis vis-a-vis salutogenesis trail of events, 'Syndromic', 'Etiological', 'Differential', 'Working' diagnosis mar the vignette with origin of DEs in 'Primary' to 'Quinary' levels till individuals return to normal health.

DEs originates from System (communication barriers, flawed investigation, manpower), Perception (mindset and decision block), Imperfect data transfer (partial data sharing), Overload (unable to obtain history, clinical profile and review records), Patient (failure to share chronological symptoms to beget apt care) [6]. A 'Electronic Health Records Analysis'

used random sample of adults from 29 facilities admitted in medical wards in United States assessed volume, aetiology, and hazards of DEs among transferee to intensive care unit (ICU) or expired; classified harms and correlated those with risk factors by 'adjusted proportion attributable fraction [7]. United States (US) White paper analyzed 2.5 Lacs indoor cases; all experiences DE once in lifetime; yearly loss of million labour days, deaths of 80,000 and economic cost U.S. $750 billion [8].

Study stressed criticality to quantify and classify DEs in primary health to improve precision and safety by mitigation plan to manage mis- and delayed diagnosis; spot and roadmap rate and nature; explore and target intervention of core and non-core risks emanating from cognitive bias, communication barriers, and resource-poor set-ups; prioritize the critical issues of DEs culminate to reduce errors and improve safety in healthcare [9]. Graber et al noted 16% of preventable harm globally from delayed, incorrect or missed DEs at every set-ups of healthcare from both HCWs and patients from array of risks specially in Low and Middle Income Countries (LMICs) viz. access, competency, fragmented care, communication, patient issue, technology, cognitive bias, system and process like follow-up [10].

In the primary care DEs take toll of millions from public health problems viz. Infective: acute respiratory infections and acute diarrhea (usually viral infections, treated with superfluous antimicrobials), Malaria, Tuberculosis (TB); Cardiovascular disease: Myocardial Infarction (MI), Stroke; Cancer; Preventable Child health issues. DEs crop up from affordability, health literacy, access to quality care due to crunch and misdistribution of resources; solutions include competent HCWs, team approach, lab back-up infrastructure; lack communication, health informatics, follow-up, culture and cognition of updating; patient characteristics and practitioner variables with and without error compared [11]. In 'Patient safety' document WHO discussed DEs on facts, sources and factors. Globally patient-doctor encounter harm are commonest sources of DEs (20%), adult admissions (0.7%); once in lifetime; health hazards of 3 million yearly, LMICs even higher (25%); cut global economic growth by 0.7%; cost US dollars of trillions [12]. UK retrospective data mining study re-defined DEs as "missed diagnostic opportunities"; 4.3% from history taking, examination or ordering tests (68%), analyzing tests (35%), follow-up (48%); 37% were moderate to severe [13].

Impact of DEs on Primary and domiciliary care in United States was reviewed by Singh et al.; noted outpatient DEs of 5.08%, or approximately 12 million US adults every year. This population-based estimate noted that half of DEs as potentially harmful and affected 1 in 20 US adults; suggested all the stakeholder viz. policymakers, healthcare organisations and researchers to find prevalence and interventions to improve patient safety [14]. DEs are linked to cognitive bias and mental shortcuts (faulty thinking) are common in high-risk and high-reliability healthcare; mitigation to be done by supplementing clinical acumen with checklists especially in Operation Theatres (OTs) and ICUs.

Checklists analyzed a. general checklist (to optimize cognition), b. differential diagnosis checklist (to avoid failure to find correct diagnosis), c. checklist of common pitfall and cognitive forcing function (evaluate selected issue). Checklists need rigorous appraisal to support intuition and memory in critical thinking n problem solving uncertainty in real time [15].

Abimanyi-Ochom et al favoured communication and audit reduce DEs by intervention viz. technology-based (62%) and in acute care setting (57%); computer-based and alert system-based algorithms reduce delay and imprecision; review team approach in trauma care and radiology limit DEs [16]. Bulk of correct final diagnosis stem from normal cognition except when cerebral process fail, usually unappreciated from intrinsic and systemic reinforced factor related overconfidence [17]. Organisation for Economic Co-operation and Development (OECD) estimated DEs in chronic illnesses slice 5% of health expenditure in member countries; 17.5% direct pooled fiscal burden of mis-, under- and over-diagnosis [18].

Challenges in diagnostic services are A. Omission: Incapacity to do a test with probability of benefit viz. Failure to screen cervical smears to eligible women. B. Commission: Quaternary prevention of a. Overuse of diagnostic test when potential harm exceeds benefit viz. Battery of test in common ailments, angiography in uncomplicated headaches etc. b. Misuse of diagnostic test to deprive full potential benefit of evidenced based medicine viz. pulmonary angiography in dyspnoea without taking past history of allergy to contrast dye [19]. Other study finds DEs in five strata viz. settings and care with optimum knowledge; assay diagnostic safety; find source of hazard; system approach instead of point of care health; updating. Choosing correct test and right processing of samples are most important mitigation measures to combat DEs from lab medicine [20]. A record and patient study noted relative role of system-related and cognitive components on comprehensive taxonomy “no fault”, “system-related”, and “cognitive”. System-related factors (policy, procedure, inefficiency, teamwork, and communication) 65%, cognitive factors 74% [21]. ‘Improving Diagnosis in Health Care’ study on diagnosing treatment framework on 2010-2015 variables found utility of diagnostic training and system improvement to reduce Des [22].

India lacks culture of reporting and recording precise medical data specially DEs. Medical Device Adverse Event Monitoring Centres (MDMCs) enhance reporting quality. Lack of communication and continuum of care to patients of abnormal test results lead to DEs of delay. Medical Device Adverse Events database under National Materiovigilance Programme (MvPI) acts as repository of adverse events reported by MDMCs. Under MvPI 174 MDMCs report adverse events from medical devices voluntarily; “Adverse Drug Reactions Monitoring System (ADRMS)” locate adverse events from application of drug, vaccine & medical device [23].

Millions of annual preventable deaths and injuries in India include missed, incorrect, or delayed diagnoses impacting treatment, well-being, and quality of life; 5.2

million medical errors occur annually and 3 million preventable death. Risk factors of DEs are poor knowledge and competency, problems in data acquisition, and synthesis of information; categorized as "No-fault", "System" and Cognitive errors; involve missing, incorrect, or delayed diagnosis leading to psycho-somatic and financial ramification. DE mitigation entails multifaceted approach to improve care, enhancing communication, and promoting culture of safety within health systems; to focus on capacity building, live teamwork and communication, updating infrastructure [24]. DEs harm to crop "medical negligence claims" viz. "Cognitive", "System", "No-fault errors". Indian research group suggested - how medical students can evade intricate interplay of cognitive and system factors that trigger DEs imperceptible to HCWs [25]. Medical mistakes including DEs mostly outcome of human factors, right technology may beat the threats by viz. augmenting mobile devices, staff communications, personalized healthcare [26].

Summary of Evidence

This systematic review outlined the burden posed by instability and errors in diagnosis on health systems, outcome, costs and care efficiency from 21 full text literatures that varied in High Income Countries (HICs) and LMICs to different disciplines and levels of healthcare.

Discussions

To champion patient safety we need training, updating, live communication among HCWs, system approach on accessibility and affordability, check lists, infrastructure upgrading and throbbing work culture in healthy Evidenced Based Medicine (EBM) based environment, create awareness on reporting of DEs in threat-free milleau. Empowering care-seekers to share negative feedbacks amid health system strengthening by digitalization, strong referral and weightage on prognostication supported by innovative telemedicine network.

WHO stressed on conceptual "System approach to patient safety" within the broader healthcare system context involving patients to advance with agenda viz. "Global action on patient safety", "Global Patient Safety Action Plan 2021–2030", "World Patient Safety Day", WHO Flagship initiative "A Decade of Patient Safety 2021–2030" [12]. WHO experts feel that DEs should be universal priority to minimize unwelcome outcomes of care in nearly half of the countries [27].

World Patient Safety Day (WPSD) is observed every year on 17 September for solidarity and united global action on patient safety and preventing hazards of health care [28].

Suggested Remedies

Enhanced Diagnostic Training

One way to solve this problem is by offering more in-depth training to clinicians, with a focus on the cognitive biases that affect diagnosis and how to mitigate them. Training should include the use of standard diagnostic checklists and protocols to reduce practice variation among the practitioners.

System Improvement

To systems need to prioritise effective communication between the members of healthcare teams and resolve workflow disruptions as a means of reducing the occurrence of diagnostic errors. Real-time decision support systems and interdisciplinary communication tools will prove useful in this scenario.

Integration of AI with Caution

Incorporation of tools of artificial intelligence into the process of diagnosis should be done gradually. We need to contain bias, caused by AI and maintain the interaction between AI and clinician, in particular, in a multicultural situation.

Checklists and Decision Support

The implementation of standard diagnostic checklists, clinical pathways, and decision support systems in the spheres of high diagnostic uncertainty, such as the emergency and intensive care medicine, will help in decreasing the prevalence of DEs to guarantee all clinicians follow best practices in every diagnosis situation.

Second Opinions and Standardization

Obtaining a second opinion for complex diagnosis cases, especially in dark areas like radiology and pathology, and standardising practice amongst the healthcare system minimizes variations and enhances diagnostic performance levels.

Targeted Approach

Focused disease model approach help reduce error rate up to 50% in conditions with a high propensity for DEs, such as strokes, sepsis, pneumonia, and cancer.

Integrated Approach Within Care

It's important to improve multidisciplinary and multi-team communication to perform the correct diagnosis. In a team-based approach, improving communication and documentation about diagnostic interpretation can help decrease the diagnostic errors in the interpretation of the patient's data.

Alerts on Quaternary and Quinary Prevention

Quaternary prevention, the fourth level public health that prevents over-diagnosis, and over-interventions; prevent iatrogenesis and ensure ethical care. Quinary prevention is latest concept in public health prevention that combats the negative effects of misinformation and pseudoscience that affect all levels of prevention from 'Primordial', Primary', Secondary', 'Tertiary', 'Quaternary' and 'Quinary' levels. It prevents optimum diagnosis with prognosis for uncertain disease progression.

Morbidity, Disability, Mortality and Diagnostic Error Audit

Diagnosis is a high risk area for errors in primary care, performing and interpreting diagnostic tests, follow-up and tracking of diagnostic information, referral-related communication and coordination, and patient behaviour, adherence and engagement. Audit at each of these points have potential to reduce DEs in difficult

clinical situations with rare disease or rare presentation.

Implications of Results for Practice, Policy and Future Research

Healthcare systems can forge ahead by using the information from this comprehensive research and implementing realizable measures to elevate patient safety and heighten health outcomes. Healthcare education courses and curriculum must receive attention to incorporate clinical decision-making skills and simulated-based learning to competencies. This includes drill of safe practice checklists with enhanced coordination, cooperation, information transfer and adherence to preventive protocol to minimize mistakes and deficiencies in compliance.

Error prevention strategies need to be incorporated in the system and tools are improvised through upgrading, regular monitoring and corrective action limit avoidable complications with focus on simulation-based training to improve technical skills and teamwork. The exchanges of messages between patients and providers are improved and plans are needed to present various risks and complications that arise from patient care. Interdisciplinary and multidisciplinary concepts are promoted to manage complicated conditions to provide integrated provision of both the biological and social aspects that influence the healing of the patients. Prospective readers will benefit from practical advice on current and crucial information on mitigation of man-made hazards to the special circumstances of tropical and LMIC countries. Summarizing data to date, this study looked into settling the great question of how mistakes affect the patients, including the overall level of care costs and inefficiency in systems to suggest creation of improved protocols, updating for staff and stronger monitoring mechanisms to enhance quality of service.

Conclusions

Healthcare hazards have downstream human, moral, ethical and financial connotation in which errors in diagnosis by healthcare provider have major chunk of contribution. Our analyses revealed scale of evidence, hazards and cost-effective interventions to limit DEs being feasible in clinical settings across HICs and LMICs. A systems approach is needed to guarantee patient safety by optimizing quality of care at every encounter with healthcare seekers, training and re-training, infrastructure development to boost precision and updating in line with the developments of science and technology.

'Once we realize that imperfect understanding is the human condition, there is no shame in being wrong, only in failing to correct our mistakes' - George Soros.

Diagnosis is *"the most critical of a physician's skills. It is every doctor's measure of his abilities. It is the most important ingredient in his professional self-image"*. Sherwin Nuland 1993

Not only are they wrong but physicians are "walking…in a fog of misplaced optimism" with regard to their confidence—Fran Lowry 1995

Author's Contribution

Concept of study (SC, RP), literature search (RP, KB), study design (RP, KB), data acquisition (AG, SC, RP), data analysis (AG, SC, RP), manuscript drafting (AG, SC, RP, KB), manuscript review, editing and final approval (AG, SC, RP, KB).

Registration and Protocol

Review was not registered and protocol was not prepared

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Conflict of Interest

All authors declare no competing interest regarding this review.

Availability of Data, Code and Other Materials

We have collected all the literature freely available to use for academic purpose from the public domain and analyzed using PRISMA checklist using data from included studies.

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