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Causes and Consequences of Medical Coding Errors: A Systematic Review of the Literature

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Abstract

Medical coding is necessary for proper record-keeping, billing, and managing health data, yet errors are still common because of organization, employees or staff and technology. These mistakes can have major effects on finances, patients and administration, which show how important it is to look into them in a comprehensive way. The objective of the research is to examine the causes and consequences of medical coding errors within the healthcare centers. Thorough A search of databases including Scopus, PsycINFO, and Web of Science to find and systematize studies that was published between 2020 and 2024. The criteria for inclusion in this research were English-language sources obtained from the specified search engines. The chosen research must also provide valuable insights into team dynamics and utilize established measuring scales. After an initial screening and quality assessment, Eleven studies were incorporated into the synthesis. On the basis of result, electronic databases to search the study database and found 34345 records. Eleven distinct records were evaluated for eligibility based on their titles and abstracts. Eleven studies were chosen for full-text review after the first screening. Eleven studies matched the criteria after an independent review and were included in the systematic review. The chosen investigations were carried out from 2020 to 2024 and exhibited diverse methodologies. The PRISMA flowchart shows how the selecting process works. Peer-reviewed journals, overall assessment, and quality management are all parts of quality evaluation. Findings revealed that medical coding errors arise from human, organizational, and technological factors, with serious consequences for patients, providers, and healthcare systems. Accurate coding is essential to safeguard patient safety, financial stability, and reliable health data for policymaking. Strengthening training, auditing, and technology integration can reduce errors and enhance healthcare quality, particularly within the Saudi Arabian context..

Keywords: *Causes, Consequences, Medical Coding Errors, Systematic Review.*

Introduction

Medical coding is one of the most important element but also one of the most difficult parts of current healthcare systems. Medical coding is the progression of turning clinical come across, diagnosis, and treatment into consistent alphanumeric codes utilize systems like the

[1] Al-Noor Specialist Hospital, Makkah
[2] Maternity and Children Hospital
[3] Makkah Health Cluster
[4] Maternity and Children Hospital
[5] Maternity and Children Hospital
[6] Al-Noor Specialist Hospital, Makkah
[7] Maternity and Children Hospital
[8] Maternity and Children Hospital
[9] Maternity and Children Hospital
[10] Makkah Health Cluster

International Classification of Diseases (ICD) and Current Procedural Terminology (CPT). These codes provide the basis for billing and getting paid back, as well as for clinical research, epidemiology, and efforts to improve quality. As healthcare is getting more advance the coding accuracy is more and more important for patient safety, the long-term health of organizations, and national health policy (Alharthi et al., 2022). Coding error is still a trouble that makes it hard for coding to do what it's thought to do.

Moreover, medical coding errors are extensive, with research indicating error rates between 09% and 31% across various clinical setting (Drosler et al., 2021). Yet a lot of funds have been spent on electronic health records (EHRs), improved coding software, and ongoing training programs for professionals, these mistakes still happen. However, it keeps happening because modern healthcare techniques are so complex. Clinicians need to document more and specific information about their patients, insurers and regulators are always changing the laws that govern coding methods and coders must correctly interpret this paperwork. Without strong systems of checks and balances, this network of interrelated needs makes coding mistakes very certain (Garg et al., 2021).

There are numerous reasons why code mistakes happen. One reason for mistakes is that people get tired, their brains are too full, or they don't get enough instruction on new coding rules. Coders typically have a lot of work to do and not enough time to do it, which makes it far more likely that they will make mistakes. In contrast, systemic vulnerabilities are caused by organizational problems such not having enough workers, not having auditing mechanisms, and not putting enough money into coding resources. Also, problems with technology are a factor. EHRs have made it easier to collect and access data, but they have also created new types of mistakes, such as copy-paste documentation, using templates incorrectly, and problems with software interoperability (Abood et al., 2023). All of these things make it more probable that mistakes will happen.

The effects of mistakes in medical coding are just as serious and far-reaching. For patients, incorrect coding might cause problems with treatment, delays in curing, or even wrong diagnose. When records don't accurately show clinical conditions, patient safety is immediately at risk, especially when coding mistakes lead to missing or misrepresented comorbidities (Abdelrahman et al., 2022). Healthcare providers face the risks of losing funds when claims are starved of, being fined for billing deception, even if it was done by misfortune, and damaging reputation, which could make patients less likely to trust them. However, coding mistakes jumble up health data, which leads to bad study results and health policy that don't work. When the underlying coding is not reliable, public health programs that rely on correct epidemiological data may fail or misallocate resources (Wu et al., 2020).

Currently, healthcare system, the shift to value-based care makes coding accuracy even more important. In value-based models, the amount of services delivered does not affect compensation; as an alternative, it is reliant on the eminence of care and patient outcomes. In this case, wrong coding might change performance measures, make patient risk profiles look wrong, and throw off financial incentives. This has a ripple effect that not only hurts providers but also leads policymakers and insurers that are trying to make healthcare more efficient in the wrong direction (Vandewater & Block, 2023).

Lastly, it's clear that mistakes in medical coding do not just mistakes made by staff; they are problems with the system that have far-reaching effects. To rule out, we need to know all the reasons why coding is wrong and all the things that can go wrong because of it. This systematic review will go into great detail about the reasons and effects of mistakes in medical coding. The study will look at how human, organizational, and systemic elements work together to cause errors, as well as how these errors affect patients, providers, and health systems. The systematic research also wants to propose ways to improve coding accuracy, patient safety, and the in general delivery of healthcare by using the consequences of recent empirical research.

Methods

Research Objective

The objective of the research is to examine the causes and consequences of medical coding errors within the healthcare centers.

Research Question

- What are the reasons and effects of medical coding mistakes in healthcare services, and how these coding error influence patients, clinicians and healthcare systems?
- What human, organizational, and technological variables lead to mistakes in medical coding in healthcare facilities
- What effect do mistakes in medical coding have on patient care, healthcare providers, and the performance of institutions?
- What are the larger effects of coding mistakes on the quality of health data and the making of policies?

Literature Search Strategy

A comprehensive search strategy was established to find relevant studies. Databases such as Scopus, PsycINFO, Google Scholar and Web of Science were searched using a combination of keywords related to "Medical Coding Error", "Causes & Consequence" and "Causes and Consequences of Medical Coding Errors within the Healthcare Centers"

Table 1

Syntax Search

Syntax 1	"Medical Coding Error" AND "Causes & Consequence"
Syntax 2	"Causes & Consequence" and "Causes and Consequences of Medical Coding Errors within the Healthcare Centers"

Table 2

Statistics from the Data Base

No	Database	Syntax	Year	No of Researches
1	Google Scholar	Syntax 1	2020 - 2024	14600
		Syntax 2		6012
2	SCOPUS	Syntax 1		5870
		Syntax 2		1238
3	PsycINFO	Syntax 1		2380
		Syntax 2		928
4	Web of Science	Syntax 1		1217
		Syntax 2		2100

The study used Google Scholar, Scopus, Web of Science, and PsycINFO databases to categorize relevant research publications from 2020-2024. The most significant articles were found in Google Scholar 20612, PsycINFO 7108 and Web of Science 3317whereas Scopus had 3308 representative thoroughness in the scientific search. The total researches were searched as 34345.

Inclusion & Exclusion Criteria

To ensure a targeted and fact-based analysis, this paper applied specific inclusion and exclusion criteria for the selection of literature. Peer-reviewed studies that find the causes or effects of medical coding errors in healthcare institutions that were published between 2021 and 2024 were included. In order to learn more about coding accuracy, the frequency of errors, and the implications of these errors for patient care and healthcare systems, the research, examined both qualitative and quantitative research studies as well as systematic reviews and meta-analyses. Researches which are in English language and others are excluded.

Quality Assessment

The studies were assessed for quality and methodological consistency using tools like the Joanna

Briggs Institute Critical Appraisal Checklist, allowing for variables like sample size, data collection techniques, research design, and potential bias. Some studies were excluded, but the results were interpreted considering each method's strengths and weaknesses.

Table 3

Assessment of the literature quality matrix

Sr #	**Author (First Author, Year)**	**Are the selections of studies described appropriately?**	**Is the literature covering all relevant studies?**	**Does the method section describe?**	**Were findings clearly described?**	**Quality Rating**
1	Jebraeily (2023)	Yes – root causes of coding errors explored	Relevant for coding error causes	Methods described (qualitative/analysis)	Findings on systemic/operational issues clear	High
2	Hutton (2021)	Yes – systematic review on barcoding	Indirectly relevant (focus on med errors)	Yes, systematic review methods clear	Yes, findings synthesized well	High
3	Walker (2021)	Yes – coding of long COVID studied	Highly relevant (large data on coding)	Yes, federated analysis described	Yes, coding trends clear	High
4	Dong (2022)	Yes – automated coding context explained	Relevant to coding technology	Describes review of automation	Findings on challenges/opportunities clear	High
5	Edin (2023)	Yes – review of automated coding replicability	Relevant to coding system reliability	Methods described for replicability testing	Findings detailed	High

6	Southern (2021)	Yes – model for coding adverse events	Relevant to the coding errors framework	Yes, the three-part model explained	Findings/framework presented clearly	Medium-High
7	Albagmi (2024a)	Yes – miscoding & financial implications	Highly relevant (Saudi hospital case study)	Yes, case study design	Findings on financial burden are clear	High
8	Albagmi (2024b)	Yes – impact of inaccurate coding	Highly relevant (financial outcomes)	Methods reported	Findings are specific and clear	High
9	Al-Subaie (2024)	Yes – role of coding technicians	Relevant (quality data)	Describes study approach	Findings clear	Medium-High
10	Alsaramı (2023)	Yes – optimization of coding systems	Relevant for system design issues	Yes, descriptive study	Findings on challenges/applications clear	Medium-High
11	Memon (2022)	Yes – near-miss incidents analyzed	Indirect relevance (patient safety coding link)	Retrospective analysis described	Findings presented but limited	Medium

The systematic review of studies provided clear descriptions, methods, selection processes, literature coverage, and clear conclusions, resulting in a "High or Good" rating for their quality.

Study Selection

In this Systematic review, the process of study selection as two independent reviewers screened retrieved studies for eligibility, then reviewed full-text articles against inclusion and exclusion criteria, with disagreements resolved through discussion or with a third reviewer

Table 4

Selected Studies for SR (Systematic Review

Author(s) & Year	Title	Journal/Source	Focus / Key Contribution
Jebraeily et al. (2023)	Identification of root causes of clinical coding problems in Iranian hospitals	*Health Information Management Journal*	Examines systemic and operational issues leading to coding errors in Iran.
Hutton et al. (2021)	The effects of bar-coding technology on medication errors: a systematic literature review	*Journal of Patient Safety*	Reviews how barcoding reduces medication errors; implications for coding accuracy.
Walker et al. (2021)	Clinical coding of long COVID in English primary care: a federated analysis of 58 million patient records in situ using OpenSAFELY	*British Journal of General Practice*	Large-scale study on coding practices for long COVID in the UK.
Dong et al. (2022)	Automated clinical coding: what, why, and where we are?	*NPJ Digital Medicine*	Reviews progress, challenges, and the future of automated coding systems.
Edin et al. (2023)	Automated medical coding on MIMIC-III and MIMIC-IV: a critical review and replicability study	*SIGIR Conference Proceedings*	Evaluates the reproducibility of automated coding models on large datasets.
Southern et al. (2021)	The three-part model for coding causes and mechanisms of healthcare-related adverse events	*BMC Med. Informatics & Decision Making*	Proposes a structured framework for coding healthcare-related adverse events.
Albagmi et al. (2024)	Assessment of clinical miscoding errors and potential financial implications on healthcare management – A case of local hospital in Najran, Saudi Arabia	*Saudi Pharmaceutical Journal*	Case study of coding errors and financial burden in Saudi Arabia.
Albagmi (2024)	Impact of inaccurate clinical coding on financial outcome: A study in a local hospital in	*F1000Research*	Focuses on financial risks of miscoding in

	Najran, Saudi Arabia		hospital management.
Al-Subaie et al. (2024)	The Impact of Medical Coding Technicians in Producing High-Quality Administrative Data	*J. of Int. Crisis & Risk Communication Research*	Highlights human expertise in ensuring coding quality and data accuracy.
Alsarami et al. (2023)	Optimizing Clinical Coding Systems: Design Principles, Applications, and Challenges	*J. of Int. Crisis & Risk Communication Research*	Discusses coding system optimization, design issues, and challenges.
Memon (2022)	A retrospective analysis of near-miss incidents at a tertiary care teaching hospital in Riyadh, KSA	*J. of Taibah University Medical Sciences*	Explores incident reporting and coding implications in patient safety.

Study Database

A systematic search of electronic databases identified 56,048 records. After removing duplicates, eleven unique records were assessed for eligibility based on titles and abstracts.

Title and Abstract Screening

The reviewer evaluated the titles and abstracts of the identified records in the first screening. Eleven studies were selected for full-text review using this process. The reviewers' disagreement was established by harmony and discussion.

Full-Text Assessment

The full texts of the Eleven studies selected. Studies were independently reviewed alongside the inclusion and exclusion criteria. Following the full-text assessment, ten studies met the criteria and were involved in the systematic review.

PRISMA Flowchart

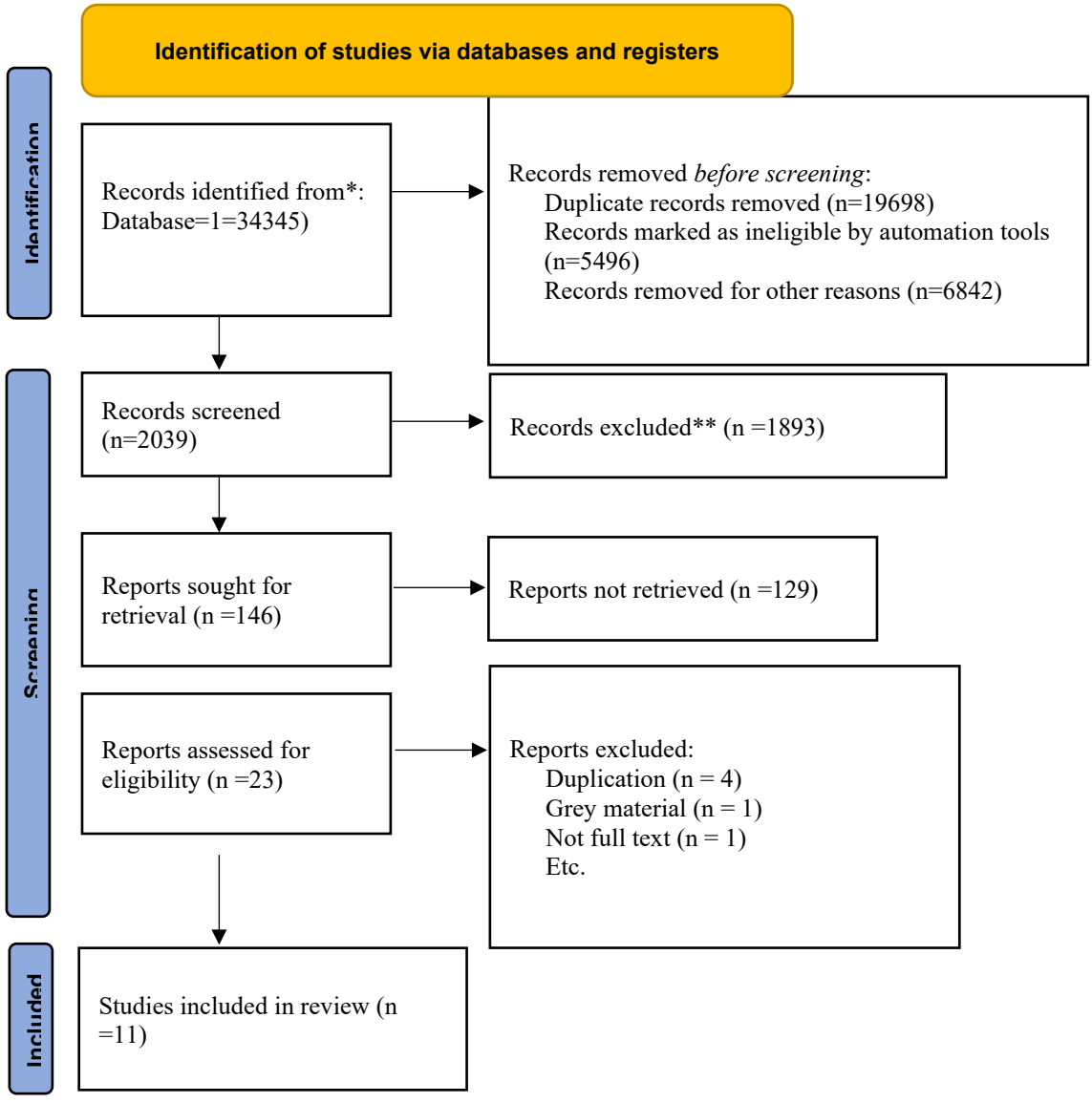
The study selection process is illustrated in the PRISMA flowchart. It provides a visual representation of the number of records at each stage of the selection process, from initial database search to final inclusion in the systematic review.

Identification of studies via databases and registers

Quality evaluation is a systematic process that includes assessing study quality using data from peer-reviewed journals, largely assessment, and quality management, providing valuable information on research techniques and pressure application.

Prisma Flowchart

Identification of Studies via Database



Data Extraction

For assessment, a uniform data extraction form was created. Key findings, participant characteristics, research characteristics (authors, publication year), and any other pertinent information were retrieved by two reviewers separately from the selected papers. Consensus was used to settle disagreements.

Table 6

Research Matrix

No	Author(s)	Year	Aim of Study	Methodology	Sample	Setting	Result
1	Jebraeily, Farzi, Fozoonkhah, & Sheikhtaheri	2023	To identify root causes of clinical coding problems in Iranian hospitals	Qualitative/descriptive	Clinical coders & hospital staff	Iranian hospitals	Found systemic, organizational, and human factors as main causes of coding errors
2	Hutton, Ding, & Wellman	2021	To evaluate the impact of barcoding technology on medication errors	Systematic Literature Review	20+ studies	International healthcare settings	Barcoding reduced medication errors but highlighted coding/entry issues
3	Walker et al.	2021	To analyze clinical coding of long COVID in English primary care	Federated analysis (OpenSAFELY platform)	58 million patient records	English primary care practices	Revealed inconsistent coding practices leading to underreporting of long COVID
4	Dong et al.	2022	To review automated clinical coding systems	Narrative/critical review	Not applicable	International research context	Highlighted progress and limitations of automated

			and applications				coding; errors linked to algorithmic gaps
5	Edin et al.	2023	To critically review automated medical coding on MIMIC datasets	Replicability study/review	MIMIC-III & MIMIC-IV datasets	Secondary data (critical care records)	Found replicability challenges; automated coding prone to inaccuracies
6	Southern et al.	2021	To propose a three-part model for coding healthcare-related adverse events	Conceptual model & case application	Not applicable	BMC dataset & case illustrations	Proposed a framework to improve coding accuracy of adverse events
7	Albagmi, Shawaheen, Asiri, & Alqadeer	2024	To assess miscoding errors and their financial implications	Case study/quantitative	Patient records	Najran, Saudi Arabia hospital	Found miscoding led to financial losses and management inefficiencies
8	Albagmi	2024	To evaluate impact of inaccurate coding on financial	Quantitative/observational	Hospital coding data	Najran, Saudi Arabia hospital	Inaccurate coding significantly affected hospital reimburse

			outcomes				ment
9	Al-Subaie et al.	2024	To investigate the role of medical coding technicians in quality data	Cross-sectional study	Coding technicians	Saudi healthcare institutions	Technicians significantly improved coding accuracy and data quality
10	Alsarami et al.	2023	To optimize coding systems and identify challenges	Descriptive/exploratory	Coding system reports & staff input	Saudi healthcare institutions	Identified design principles, challenges, and improvement strategies
11	Memon	2022	To analyze near-miss incidents in a tertiary care hospital	Retrospective study	Patient safety incident reports	Riyadh tertiary care hospital	Identified coding-related safety risks and gaps in reporting accuracy

Findings

Data Synthesis

The research suggested that medical coding errors are caused by a mix of human, organizational, and technical causes, and they can have a wide range of effects on administration, clinical and financial matters. Researchers have shown that automation and bar-coding can help improve accuracy in different healthcare settings (Iran, Saudi Arabia, the UK, and international reviews), but there are still troubles with training, consistency and system design.

Table 7

The following sub-themes have been observed among the studies, including in the systematic

review.

No	Themes
1	Medical Coding Errors Associated with Human
2	Medical Coding Errors and Organizational influence
3	Medical Coding Accuracy & Technological Usage
4	Medical Coding & Patients Satisfaction

Discussion

The systematic review typically summarized the outcomes of eleven researchers (2020 to 2024) each focusing on various sides of medical error codification. Together, the studies verify that errors are multi-factorial human, organizational, and technology based, with high-impact consequences on patient safety, financial stability, and health care systems functioning.

Jebraeily et al. (2023) focused on human factors and systemic aspects and discovered the root causes of the 89 expressed coding errors in Iranian hospital settings; these sites include coder fatigue, lack of training, and systemic issues. This substituted the results reported by Al-Subaie et al. (2024), who discovered that the administrative data quality generated by coding technicians depends on the significance of professional knowledge and training. In line with this, Memon (2022) reviewed near-miss events in one of Saudi tertiary hospitals and showed that classification mistakes undermine patient safety, resulting in reporting omissions and bias in identifying clinical risks.

A number of studies covered technological perspective. Dong et al. (2022) conducted a review of automated coding systems and focused on the advantages of automation and the weakness of this tool in generating reliable information. In the same spirit, Edin et al. (2023) found that automated coding models used with MIMIC datasets have reproducibility issues, as algorithmic outputs are still susceptible to errors. Hutton et al. (2021) examined barcoding technologies and reported a decrease in medication errors and observed that systemic integration problems and data entry difficulties could eradicate the overall accuracy of coding. All these studies point in one way (that technology could facilitate accuracy) but not replace human supervision.

Walker et al. (2021) conducted a study that explored the coding for long COVID in the UK based on 58 million patient databases, thereby demonstrating the clinical and epidemiological implications. Their results showed discrepancies which resulted into underreporting which has implications in relation to the healthcare planning during a public health crisis. A three-part model of coding adverse events in healthcare was created by Southern et al. (2021) which will provide an example helping to minimize variability and enhance the standardization of errors permanently.

In Saudi Arabia, organizational and financial impacts were particularly emphasized. Albagmi and colleagues (2024a) also discovered that miscoding in one of the hospitals in Najran led to losses and inefficiencies in the management of the hospital. Albagmi (2024b) followed up the study and confirmed that erroneous coding was detrimental to the accuracy of reimbursement to an extent of imperilling financial viability. Moreover, Alsarami et al. (2023) also emphasized barriers in the optimization of codification at the organizational and system levels, which detect the issues in the design and difficulties associated with the implementation that limit effective working processes.

In general, these results indicate that medical coding errors are not attributable to single elements, but they are due to the uninterrupted combination of human error or professional error, technological constraints, and internal company deficiencies. They impact both patients (risks to their safety, delays in treatment), providers (financial fines, damaged reputation), health systems (misaligned policies, falsified epidemiological evidence). The solutions should thus be multi-dimensional and hence include training, technology and system redesign.

Limitations

There are a number of limitations to this systematic review. The first restriction is that the time frame was limited as only the studies published after 2021 were considered. This may have locked out previous yet pertinent studies that may have given some historical impresses of how the codices were practiced. Second, it is formed that the review only reviewed English language studies, thus it has set up a language bias that might have omitted the works that were published in Arabic or other regional languages that might have provided worth on information maybe especially in the Middle East or Saudi Arabia setting. Thirdly, it is likely that important grey literature studies or policy reports and region-specific journals were missed because four giant databases were searched, including Scopus, PsycINFO, Web of Science, and Google Scholar. The other weakness is that the nature of the studies included is rather methodologically diverse. The nature of the reviewed studies, because of the difference in case studies and retrospective analysis and systematic review and conceptual frameworks, it was hard to make a direct comparison and/or meta-analysis in the reviewed studies. Lastly, the generalisation of the findings might be the particular case, since it is possible that studies in countries like the UK or Iran are not broadly applicable to the particular environment of Saudi Arabia in terms of healthcare, finances and regulation, but they may offer valuable insights to place Saudi Arabia in context.

Recommendations

The results of this review make possible to propose some important pieces of advice on making essential amendments to programming and minimize the effects of mistakes. To maintain awareness of variations in classification systems used like ICD and CPT, healthcare institutions must focus on improving training and certification of individuals to be code professionals. The adoption of effective auditing systems which may identify errors in their early stages thus preventing financial losses due to rejected claims or denial of reimbursements are equally important. Work environment and proper staffing should be highlighted as well because fatigue and workloads were noted very often by coders as the major contributors to errors. Hospitals

need to adopt technologies like artificial intelligences aided code and barcoding and combine them with human supervision as a way of maintaining a proper balance between efficiency and accuracy. Governments and health authorities must, at the policy level, codify national standards of coding, positively correlate coding performance with accreditation systems and introduce accountability mechanisms to uphold high-quality standards in coding practices.

Implications

A broad range of implications of this review exist in relationship to patients, providers and healthcare systems. To the patients, proper coding leads to proper reporting of diagnosis, continuity of care and safer treatment decisions. To healthcare providers, proper coding protects institutionalists earnings and lowers chances of sanctions and also enhances confidence to the watchdogs and the patients. Dependable coding at the system level helps to have the correct epidemiological data, fruitful policymaking, and correct distribution of resources, just in time when healthcare goes through the new models of value-based care. Technologically, the implications of the findings include that although automation is efficient, it must be designed as a supplement solution over a replacement of human professionalism; hence the need to enhance the integration of systems whereby technology and professional judgment work together to achieve effectiveness.

Saudi Arabian Relevant Lessons.

The Saudi Arabian studies used in this review present a particularly valuable piece of information regarding the local context. Miscoding has been reported to lead to the incurring of vast amounts of financial loss, this is particularly alarming as the Kingdom moves towards privatized and value based healthcare within the context of Vision 2030. The existence of such financial hazards supports the fact that effective methods of quality assurance and internal audit procedures are necessary in all hospitals as an urgent matter. A second significant learning point is that medical coding technicians are vital. These professionals need to be given the funding on training, in order to make sure accuracy of the data and aided decision-making. In addition, the coding accuracy should be the part of the patient safety frameworks in Saudi Arabia because mistakes have been directly connected with the lack of the incident reporting and risk evaluation. Finally, it is crucial to harmonize healthcare data by standardizing coding practices in the public and private sectors, which is possible only when the available healthcare data is standardized on a national level.

Conclusion

To sum up, the current systematic review indicates that error in medical coding is caused by a multifaceted blend of human, organizational and technological factors, and carry far-reaching effects on patients, providers and healthcare systems. The data indicate that technological methods of enhancing accuracy like automation and barcoding are promising; however, they cannot fulfill their potential without the assistance of human, well-trained supervision and a well-structured system within the company. The findings in the Saudi Arabian environment have the essential importance due to the fact that inaccurate coding in this country has a direct impact on financial sustainability and patient safety, and, thus, it is necessary to institute some changes in

the system as soon as possible. Healthcare facilities in Saudi Arabia can do much to decrease their errors by intensifying the training of coders, using an auditing system, minimizing workloads, and introducing national coding standards. These actions will improve patient safety, guarantee financial security, and increase the trustworthiness of health-related data, which will in turn grapple the objectives of the Vision 2030 and promote the quality and efficiency of healthcare provision in the Kingdom.

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