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Analyzing the medical record homepages quality in a Chinese EMR system

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Abstract

Background The medical record homepage represents the core and quintessential distillation of the entire medical record. This study aims to investigate the problems with the medical record homepages data quality after the upgrade of the electronic medical record system, while simultaneously proposing practical and feasible measures to catalyze substantive improvements in data quality standards.

Methods A retrospective analysis of data extracted from the medical record homepage system was conducted at a Chinese tertiary hospital affiliated with a medical university between January and December 2021. Analysis of Moment Structures (AMOS) was used to construct a structural equation model, with the aim of elucidating the influence of individual variables on dependent variables. Furthermore, a fish bone diagram analysis was utilized to systematically analyze the underlying causes of quality defects.

Results Among the 2,731 medical record homepages subjected to scrutiny, a substantial proportion of 1,531 records (56.1%) exhibited quality issues. The structural equation model revealed that patient demographic information exerted the most profound influence on data quality, as evidenced by the greatest value of the standardized total effects (β = -0.729), followed by surgery (β = -0.606) and diagnosis information (β = -0.363). Moreover, the fish-bone diagram analysis was employed to systematically dissect the underlying causes of quality defects in the medical record homepages, encompassing human factors, surroundings, regulatory system, and machinery.

Conclusions The predominant factor contributing to the poor data on the medical record homepage was inaccuracies in demographic information, closely followed by errors in surgical and diagnosis information. It is helpful to improve the data quality of the medical record homepages by establishing a coder qualification certification system, strengthening the construction of medical informatization, and adding data validation and prompt functions.

Keywords Electronic medical record, Information management, Data quality, Medical record homepage

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Background

The Electronic Medical Record (EMR), alternatively referred to as the Computer-Based Patient Record (CPR) or the Electronic Health Record (EHR) [1], is a crucial component of modern healthcare systems. Over the past few decades, Health Information Technology (HIT) has garnered widespread promotion and advocacy from governments across the globe, substantially augmenting the adoption and utilization of electronic medical records, exemplified by initiatives such as the United Kingdom's Summary Care Record Policy [2], the United States' American Recovery and Reinvestment Act (ARRA) [3, 4], and Japan's E-Japan strategy [5]. Moreover, in 2018, the National Health Commission of China promulgated the nine-level policy framework for hierarchical evaluation and management of EMR systems, mandating that tertiary hospitals within the country attain a minimum of level three by 2019 and a minimum of level four by 2020 [6]. However, an investigation conducted by the National Health Commission revealed that in 2020, the average application level of EMR systems in national hospitals was a mere 2.43 [7], falling markedly short of the mandated standards. Although data exchange has been largely established, it nevertheless falls markedly short of attaining the requisite level four standards [5, 8]. Myriad issues persist concerning the integrity and accuracy of EMR data across various hospitals, with the overarching goals of information integration, unified data management, and hospital improvement remaining largely unaccomplished. Consequently, it is imperative to conduct a profound and comprehensive analysis of the underlying causes contributing to the lack of data integrity and accuracy.

The medical record homepage represents the core and quintessential distillation of the entire medical record, a document employed by hospital administrators to synthesize and encapsulate all pertinent medical information pertaining to patients during their hospitalization period [9]. Subsequent to each patient discharge, a new medical record homepage is generated, accompanying the complete medical record. It is comprised of four fundamental components: demographic information, hospitalization process information, diagnosis and treatment information, and medical cost information [10]. Evidently, the information encapsulated within the medical record homepage serves as a significant and invaluable data source for the hospital's scientific research, teaching, medical quality management, and payment for medical insurance [11, 12].

Electronic Medical Records (EMRs) have consistently remained a prominent research hotspot, encompassing applications aimed at enhancing medical quality [13, 14], optimizing medical management [15, 16], fortifying disease detection, prevention, and surveillance efforts [17–19], as well as leveraging novel technologies and methodologies to elevate the data quality of EMRs [20, 21]. Furthermore, the accessibility and security aspects of EMRs have been subjected to extensive scholarly investigation [22–24]. The medical record homepage represents a unique medical information management form within the Chinese healthcare context, and research endeavors pertaining to it have primarily encompassed defect analysis of the homepage's coding [25], quality assessments of specialized subject medical record homepages [11], and the examination of prevailing issues on medical record homepages through descriptive analytical methodologies [9, 12]. However, preceding studies have frequently been constrained by a narrow focus on technical efficacy or a proclivity towards streamlining research methodologies and content, thereby failing to fully elucidate their intrinsic breadth and depth. This study employed a multifaceted research approach to conduct a comprehensive quality assessment of the content on the medical record homepages from multiple perspectives, uncovering the underlying issues obscured by the data and providing robust support for the continuous enhancement of medical quality.

Consequently, this study aimed to utilize a large tertiary hospital sample in China to explore the flaws in the data of the medical record homepages. By identifying the specific flaws and the underlying causes in medical record homepages, targeted improvement strategies can be developed to effectively enhance the standards and accuracy of electronic medical records.

Methods

Design and setting

A retrospective cross-sectional qualitative research study evaluating the quality of medical record homepages was conducted in 2021 at a medical university-affiliated hospital in China. This institution represents the largest comprehensive tertiary hospital in southern Anhui Province, China, serving a catchment population of 5.3 million individuals. Moreover, this hospital's medical record management department serves as the location of the provincial medical record management center and has garnered recognition as a national excellent Medical Record Management Center.

Variables and measurements

Dependent variable: Medical record homepages quality score was calculated by each incorrect independent variables, for which 0.5 points were deducted, and the cumulative deduction did not exceed 5 points. This is because the data quality on the medical record homepages only accounts for 5 points in the medical quality assessment of the hospital. Furthermore, 5 points were deducted directly for some extreme problems, such as too many

blank fields and mixed with other people's information, which refers to the medical record number being connected to another patient's homepage information. In developing the structural equation model, the quality of the medical records homepages was categorized into five levels: very good (no errors), good (1–2 errors), average (3–4 errors), poor (5–6 errors), and very poor (exceeding 6 errors). These categories were assigned ordinal values of 5, 4, 3, 2, and 1, respectively.

Independent variables: There are a total of 33 independent variables in this study. 32 independent variables were the fields that were found to have errors in the sections of demographic information (excluding the name, identification number, and hospitalization number), diagnostic information, surgical information, and hospitalization process information. In this study, any incorrect medical cost information was not found. The 33 independent variables in this survey were divided into five parts: demographic information, diagnostic information, surgical information, hospitalization process information, and extreme issues. All variables were assigned a value of 1 for having a defect and 0 for being correct.

The fish bone Diagram, which is also referred to as the Characteristic Factor Diagram, Cause-and-Effect Diagram or Ishikawa Diagram, is a method devised by Japanese management guru Kaoru Ishikawa for analyzing the root causes of problems [26, 27]. In this study, it is used to analyze the reasons for the poor data quality of medical record homepages from four aspects: human factors, surroundings, regulation system, and machinery.

Data collection

In this study, 10 medical record homepages were randomly selected each month from 49 clinical departments in 2021. All homepages would be selected if fewer than ten discharged patients were available in some clinical departments. Consequently, a substantial corpus of 2,731 medical record homepages was amassed for rigorous evaluation. These homepages underwent a meticulous review process conducted by six coders, four medical record quality control personnel, one statistician, and two clinical experts, all of whom adhered strictly to the relevant standards and policies governing the appropriate completion of medical record homepages [10]. Furthermore, interviews were conducted with doctors, nurses, medical record administrators, quality control personnel, and hospital administrators to explore the reasons for incorrect fields in this study. Subsequent to this comprehensive data collection process, the reasons for the suboptimal data quality of medical record homepages were systematically synthesized and categorized into four distinct aspects: human factors, surroundings, regulatory system, and machinery.

Analysis

First, in this study, the results of the normality tests for the independent and dependent variables did not meet the criteria for a normal distribution ($P<0.05$) according to the Kolmogorov-Smirnov test and Q-Q plot method. Accordingly, a non-parametric test (Mann-Whitney U) was employed to determine the association between the home page data quality and the independent variables. Second, AMOS was used in this study to construct complex statistical models and conduct in-depth analyses of the relationships and path coefficients between independent variables and the quality of medical record homepages. Finally, fish bone diagram analysis was used to analyze the causes of data quality defects in the medical record homepages. All statistical analyses were performed using SPSS 22.0 and AMOS 21.0.

Results

Analysis of data quality on the medical record homepages

Of the 2,731 medical record homepages analyzed, 1,531 (56.1%) had quality problems. In this study, the $\bar{x} \pm s$ of the scores on the medical record homepages was 0.420±0.556. In total, 33 defects were identified in 1,531 medical record homepages in this survey. The most common defect was in addresses in demographic information, with 243 medical record homepages, accounting for 8.9%. The next most common was other surgery information in surgical information, affecting 180 (6.6%) homepages. Following this was Activities of Daily Living (ADL) in hospitalization process information, found in 144 (5.3%) homepages. Notably, non-parametric tests revealed statistically significant relationships ($p<0.05$) between these independent variables and the dependent variable, such as marital status, main diagnosis, and major surgery (See Table 1).

Path analysis of data quality on the medical record homepages

Statistically significant independent variables and dependent variable were entered into Amos for path analysis. The absolute value of the standardized total effects, given by the structural equation model, can clearly show the magnitude of the impact of each variable and its relevant part on the quality of the medical record homepages (See Fig. 1). The study found that demographic information (β = -0.729) had the greatest impact on the data quality of the medical record homepages, followed by surgery (β = -0.606) and diagnosis information (β = -0.363), hospitalization process information (β = -0.204), and extreme problems (β = -0.099). All fitting indices showed that the final path model was fully representative of the data.

Table 1 Data quality analysis on the medical record homepages

Variables	Number of defects		Z	P
	N	%		
Demographic information				
Marital status	34	1.2	-5.365	0.000
Newborn weight	7	0.3	-2.196	0.028
Contact person	126	4.6	-12.012	0.000
Address	243	8.9	-14.322	0.000
Admission pathway	21	0.8	-5.053	0.000
Age	34	1.2	-7.17	0.000
Department transfer	130	4.8	-13.818	0.000
Occupation	50	1.8	-7.962	0.000
Diagnosis information				
Admission illness state	48	1.8	-7.308	0.000
Admission diagnosis	88	3.2	-9.336	0.000
Principal diagnostic	92	3.4	-10.105	0.000
Other diagnoses	45	1.6	-7.195	0.000
Discharge condition	9	0.3	-5.546	0.000
External causes of injury or poisoning	15	0.5	-3.167	0.000
Pathological diagnosis	55	2	-7.95	0.000
Diagnosis time	44	1.6	-6.862	0.000
Surgical information				
Principal surgery	119	4.4	-14.148	0.000
Other surgeries	180	6.6	-15.079	0.000
Surgical assistant	139	5.1	-12.789	0.000
Operation time	73	2.7	-12.072	0.000
Anesthesia information	51	1.9	-6.49	0.000
Surgical level	22	0.8	-6.66	0.000
Hospitalization process information				
Signatures	88	3.2	-11.507	0.000
Infectious disease report	24	0.9	-6.045	0.000
Blood type	19	0.7	-4.127	0.000
Allergic medicines	20	0.7	-5.077	0.000
Hospital discharge way	104	3.8	-10.289	0.000
ADL	144	5.3	-14.284	0.000
Blood transfusion	15	0.5	-6.687	0.000
Critical state	64	2.3	-11.127	0.000
Nursing days	41	1.5	-9.386	0.000
Antibiotics use	39	1.4	-8.007	0.000
Extreme issues	6	0.2	-4.548	0.000

Note. A: medical record homepages quality; B: demographic information; C: diagnosis information; D: surgical information; F: hospitalization process information; G: extreme issues; b1: occupation; b2: department transfer; b3: age; b4: admission pathway; b5: address; b6: contact person; b7: marital status; c1: admission illness state; c2: admission diagnosis; c3: principal diagnoses; c4: other diagnoses; c5: external causes of injury or poisoning; c6: pathological diagnosis; c7: diagnosis time; d1: surgical level; d2: anesthesia information; d3:operation time; d4: surgical assistant; d5: other surgeries; d6: principal surgery; f1: signature; f2: infectious disease report; f3: blood type; f4: allergic medicines; f5: hospital discharge way; f6: ADL; f7: critical state; f8: Nursing days; f9: antibiotics use

Fishbone diagram analysis

The fishbone diagram was used to analyze the causes of these defects from four perspectives: human factors, surroundings, regulation system, and machinery. In terms of human factors, we analyzed the reasons from the viewpoint of medical staff, patients, clinical directors, and medical record managers. From the perspective of surroundings, the time limit for filling in medical records, the delay in examination reports, and the imperfection of the coding library were taken into account. Rules and regulations included not adhering strictly to reward and punishment systems, overemphasizing major diagnoses and major surgeries, and failing to implement effective special training. A lack of automatic data capture, insufficient rules checking ability, low level of informatization, and poor system interoperability and sharing were factors considered for the machinery factor (See Fig. 2).

Discussion

In this rigorous and comprehensive study, a meticulous quality review was conducted to analyze the defects and lapses in data integrity that plagued the medical record homepages. The results revealed that demographics information, surgical information, and diagnostic data were the main sources of data quality errors on the homepages. The reasons for the poor quality of the homepage included human factors, surroundings, regulation system, and machinery.

Contrary to previous studies [12, 28, 29], our study demonstrated that the demographic information defect was the predominant cause of poor homepage data quality. This disparity can be attributed to the long-standing emphasis and prioritization placed on diagnosis and treatment information, with a particular focus on major diagnoses and major surgical procedures. Numerous studies by Zhang Hongwei, Wang Yong, Zhang Yanting, and Li Li all emphasized errors in diagnosis and surgical information, yet they overlooked the the critical review of patients' basic information [29–32]. However, the implementation of Diagnosis Relate d Groups (DRG) and Diagnosis-Intervention Packet (DIP) has elevated the importance of patient information, such as gender and age to a critical level. DRG and DIP were important tools for assessing the quality and efficiency of medical services, and play a crucial role in determining medical insurance payments [33–35]. Inaccuracies or errors in these demographic information can profoundly affect the enrollment rate of DRG and DIP, subsequently affecting the assessment of hospital medical quality and the corresponding medical income. Beyond its significant impact on medical payments, demographic information defects also have far-reaching implications for disease management [36–38]. Garies's study has demonstrated that the incompleteness of patients demographic information in electronic medical record systems adversely affects the accuracy of hypertension epidemiological statistics and disease surveillance data [36].

This study discovered that the accuracy of surgical and diagnosis information significantly impacts the medical

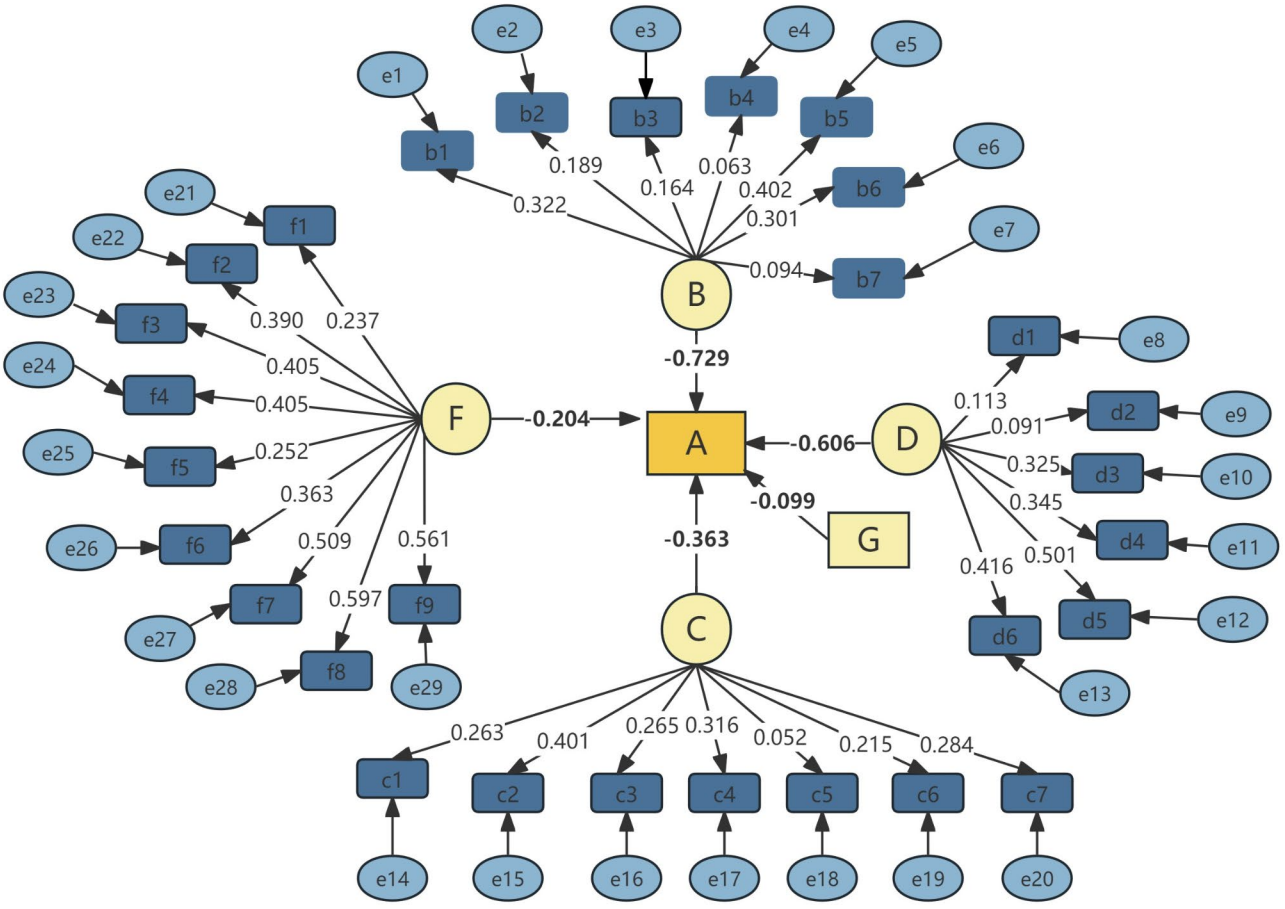

Fig. 1 Structural equation model for the quality of the medical record homepages

record homepages quality. This finding has been corroborated by a multitude of studies [39–41]. Studies from various nations indicated that the integrity and accuracy of these information significantly impact disease monitoring, medical insurance billing, scientific research, and hospital management [42–44]. Moreover, this hospital implemented DIP medical insurance settlements in 2021, which resulted in a total loss of 190 million yuan. The reasons included the wrong selection of the main diagnosis and main surgery, omission and overfilling of other diagnoses and other surgeries, unreasonable use of drugs. In this study, it was also determined that extreme problems and information regarding the hospitalization process are also contributing factors to the quality defects of the homepage. Other studies have also emphasized that these information were important factors affecting the quality of medical records homepages [45, 46]. High-quality medical record data is the driving force for optimizing medical data standards and norms. Studies suggested that when electronic medical record systems adhere to unified data standards and interface specifications, the exchange of medical information among different medical institutions, regions, and even countries will become smoother [47–50]. This is of great significance for optimizing the allocation of medical resources, facilitating cross-regional medical collaboration, and enabling telemedicine consultations. Therefore, improving the quality of electronic medical record data is an important driving force for promoting medical informatization and facilitating global medical cooperation and sharing.

We also analyzed the reasons for the poor quality of the medical record homepages from four aspects: human factors, surroundings, regulation system, and machinery. This was similar to the results of other studies [51–54]. The difference from them is that we use a fish bone diagram to analyze the underlying reasons for the poor quality of the medical record homepages. This makes the results more systematic and visualized. And the usual reasons for these problems are as follows: firstly most medical records are completed by interns, continuing education students, and resident training doctors. Secondly, the underdevelopment of coding teams and inadequate coding libraries. Thirdly, lack of clear rewards and punishments and accountability exacerbates issues. Fourthly, low informatization in electronic records causes inefficiencies. Lastly, multiple manufacturer

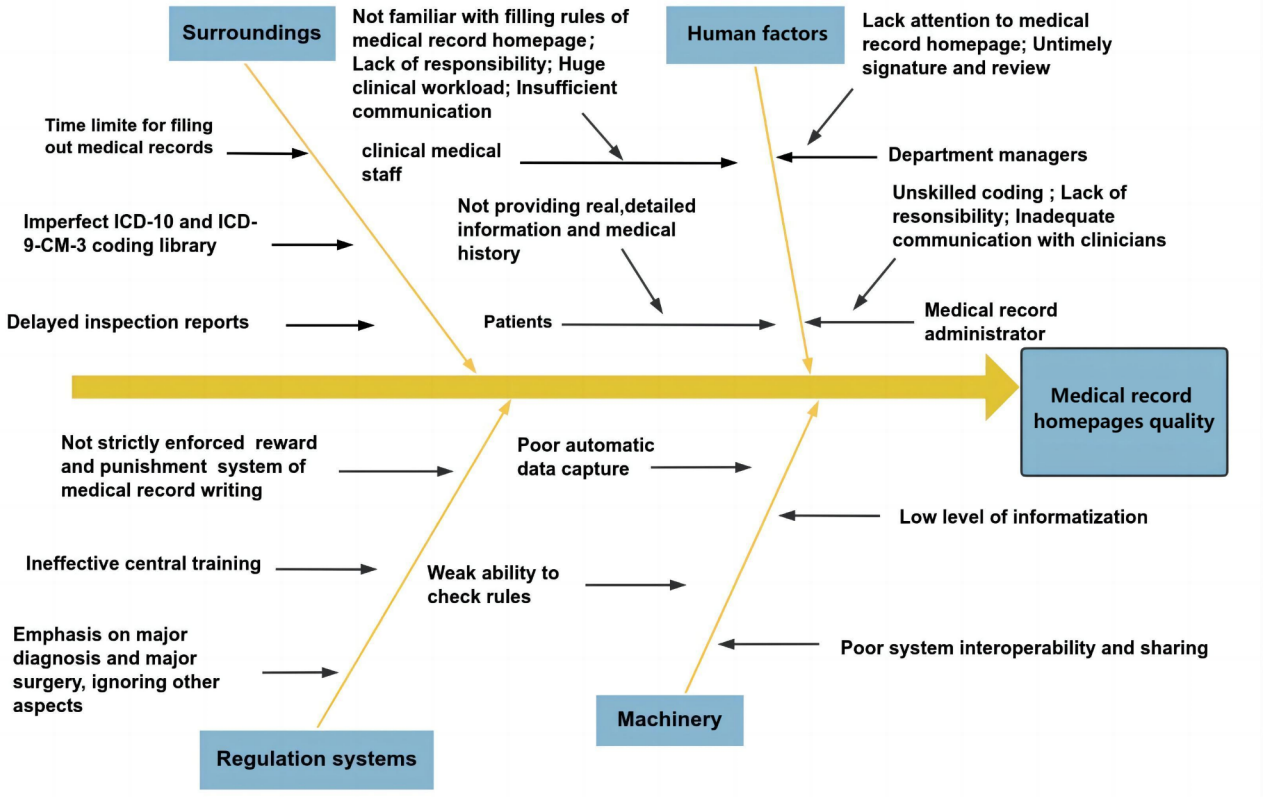

Fig. 2 Fish bone diagram analysis of medical record homepages problems

systems create interface complexity, hindering data standardization [46, 55], further compounding the challenges of achieving seamless and consistent medical record management.

The above research results have several points worthy of our attention. Medical institutions should strengthen the training and assessment of coders. Establish a coder qualification certification system would ensure adherence to rigorous standards, elevating the profession and safeguarding data integrity. Concurrently, a reinvigorated emphasis on information technology construction, leveraging the power of AI (Artificial Intelligence) for real-time monitoring of medical record front page data, would usher in a new era of proactive quality control. Additionally, data validation and prompt functions should be seamlessly integrated into the system, acting as sentinels against errors and omissions. Moreover, data integration and sharing among various systems should be enhanced, promoting a seamless flow of information and facilitating collaborative care. Furthermore, policymakers in healthcare should formulate relevant policies to support medical information technology construction, such as providing financial subsidies, tax incentives, and other measures, recognizing the critical role of technology in driving healthcare excellence.

The quality issue of medical data is a global challenge that transcends borders and healthcare systems. Although the forms of electronic medical record systems in different countries are different, the data quality issues they face are common, underscoring the universality of this struggle. This study provides important reference and guidance value for medical institutions and countries grappling with similar data quality issues.

Limitation

This study has some potential limitations. First, because the study was retrospective, it was unable to determine the causal association between the defects of basic information, diagnosis and surgical information and the quality of medical record homepages. Second, this study did not obtain the errors about medical cost information. Third, the study only collected data from one general hospital, not from others. Fourth, this study was carried out in a single province and city in China, and because of disparities in economy, geographical location, and customs of culture, it remains unclear whether the findings may be seamlessly generalized to other provinces and cities. In future work, we are committed to conducting follow-up research on hospitals of different types, scales and geographical locations, aiming to comprehensively

understand the medical record homepages quality in different situations and ensure the extensive applicability and robustness of research findings.

Conclusion

This study found that defects in the demographic information, surgical information and diagnostic information were the primary contributors to data quality of the medical record homepages and analyzed the causes from the perspectives of human factors, surroundings, regulation system, and machinery. Overall, our research can provide valuable insights into the quality of medical record homepages in China and serve as a catalyst for global medical data sharing and cooperation.

Abbreviations

AMOS	Analysis of Moment Structures
EMR	Electronic Medical Record
CPR	Computer-Based Patient Record
EHR	Electronic Health Record
HIT	Healthcare Information Technology
SCR	Summary Care Record
ARRA	American Recovery and Reinvestment Act
DRG	Diagnosis Related Groups
DIP	Diagnosis-Intervention Packet
ICD	International Classification of Disease

Supplementary Information

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Supplementary Material 1

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Author contributions

The authors confirm their contribution to the paper as follows: Study conception and design: DG and YX. Data collection and Analysis: DG, YX and ZZ. Writing: original draft or/and review & editing: DG and YX. All authors read and approved the final manuscript.

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Data availability

The data that support the findings of this study are available from the First Affiliated Hospital of Wannan Medical College, but restrictions apply to the availability of these data, which were used under license for the current study, and so are not publicly available. Data are however available from the authors upon reasonable request and with permission of the First Affiliated Hospital of Wannan Medical College.

Declarations

Ethics approval and consent to participate

This study was conducted according to the ethical guidelines of the Helsinki Declaration and was approved by the Ethics Committee of the First Affiliated Hospital of Wannan Medical College (Yijishan Hospital). The Ethics Committee of the First Affiliated Hospital of Wannan Medical College (Yijishan Hospital) exempted informed consent because of the retrospective nature of this research. Prior to the analysis, the names of patients and other key information for personal identification were anonymized and de-identified.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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