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THE RELATIONSHIP BETWEEN QUALITY AND INFORMATION SECURITY MANAGEMENT, AND SAFETY CLIMATE IN HEALTHCARE

Abstract: *The purpose of this paper is to determine the functional relationships among information security, patient safety climate, and quality management dimensions within a healthcare system. A cross-sectional, observational study was conducted among the healthcare staff of a state university training and research hospital. The safety climate scale and quality and information security management (QISM) scale were used to collect data from a sample of 389 participants. Canonical correlation analysis was conducted to evaluate the relationship between QISM and safety climate. Organizational safety and departmental safety were the strong contributors to safety climate while quality management, information security, and general requirements, contributed to the QISM. Examining the signs of the cross loadings indicated that all the independent and dependent variables positively correlated with safety climate, and QISM. The results indicated a significant and robust positive relationship between QISM and safety climate. Making improvements in quality and information security may provide positive results on improving patient safety climate. Along the same lines, promoting a patient safety climate may also improve healthcare quality and information security.*

Keywords: *Information Security, Patient Safety, Safety Climate, Quality Management, ISO 27001, Health Information Technology*

1. Introduction

Healthcare is one of the major industries impacted by advances in Information Technology (IT). Developments in Artificial Intelligence (AI), Machine Learning (ML), Deep Learning (DL), Neural Networks (NN), chatbots, smart biosensors, and predictive data analytics have triggered genuinely amazing innovations (Cockburn, Henderson, & Stern, 2018; Lee, Suh, Roy, & Baucus, 2019). AI along with ML, DL, NN has enhanced clinical diagnosis and decision-making performance in several medical task domains, expanding into applications of medical image diagnostic systems, clinical practice (Jha & Topol, 2016), translational medical research (Golub et al., 1999) and basic biomedical research, all of which were once considered to be a domain of human experts (Yu, Beam, & Kohane, 2018). Mimicking human cognitive functions, AI brings a paradigm shift to healthcare, powered by increasing healthcare data availability and rapid progress of analytics techniques (Jiang et al., 2017).

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Latest applications of Augmented Reality (AR), Virtual Reality (VR), Mixed Reality (MR), and Extended Reality (XR) open the door for possibilities that were unimaginable before (Flavián, Ibáñez-Sánchez, & Orús, 2019; Freeman et al., 2017). Mobile technologies such as device management, mobile application development tools, 5G networks, mobile analytics, metrics, monitoring, wearables, image and video processing, and next-generation devices have become an essential part of healthcare IT and telemedicine (Lin, 2012; Martínez-Pérez, De La Torre-Díez, & López-Coronado, 2013). The data-driven technological advances connecting physical devices that have sensors worn on the body or embedded in the environment are commonly known as the Internet of Things (IoT) (Da Xu, He, & Li, 2014; Hassanalieragh et al., 2015). IoT has caused an explosion of interconnected devices supporting medical providers and patients (Thibaud, Chi, Zhou, & Piramuthu, 2018), providing healthcare assessment, including monitoring patients and automatically detecting situations where medical interventions are required (Tarouco et al., 2012). The IoT-based applications and devices from various vendors significantly increase the speed and efficiency of data flow and allow greater and easier access to health records and related patient medical information (Fernandez & Pallis, 2014). They also improve quality of healthcare services and cost efficiencies (Couturier, Sola, Borioli, & Raiciu, 2012) reducing medical errors and increasing patient safety with optimized processes (Turcu & Turcu, 2013). IoT-based healthcare allows a customer-centric environment to engage patients in their healthcare (Amendola, Lodato, Manzari, Occhiuzzi, & Marrocco, 2014; Koop et al., 2008). Additionally, Quality 4.0 is the digitalization of Quality Management, and how this digitalization improves the culture, organization, skills, capabilities, and leadership of organizations. It emphasizes not only product quality, but also improvement of the performance processes and safety. As a result of these improvements done via Quality 4.0, organizational activities will be more efficient when also supported by information technology systems and traditional quality methods (Broday, 2022).

Overall, technology has driven healthcare to be efficient and effective and be entirely dependent on medical devices and electronic health records. Despite all the benefits, there are challenges and associated risks. The rapid adoption of mobile technologies by clinicians and patients without proper measures is a major problem (Martínez-Pérez, De La Torre-Díez, & López-Coronado, 2015). It raises critical security and privacy issues since highly sensitive health information is collected (Zhang et al., 2015). Good strategies and mechanisms should be in place to ensure security, privacy, safety, and quality of care (Tarouco et al., 2012). According to Babar, "having every 'thing' connected, new security and privacy problems arise, e.g., confidentiality, authenticity, and integrity of data sensed and exchanged by 'things' (Babar, Mahalle, Stango, Prasad, & Prasad, 2010). The design flaws in medical IT and IoT systems allow an intruder to gain unauthorized access, modify critical patient data, or make the system unavailable by conducting denial-of-service attacks, reducing the quality of care and, more importantly, putting the patient's safety at risk (Abomhara, 2015) making healthcare a prime target for increased cyberattacks (Davis, 2020; Widup, Spitler, Hylender, & Bassett, 2018).

Similar to unintentional medication errors, if the medical and patient data are not securely protected, in the wrong hands they can be altered, i.e., wrong dose, wrong medication, or wrong treatment procedures, and potentially can impact the safety of the patient (Hughes & Blegen, 2008; J. Wang, Zhang, Xu, Yin, & Guo, 2013). Also, the unavailability of medical and patient data due to cyberattacks could cause harm. Ransomware, a form of cyberattack, copies files, encrypts them, holds the key to decrypt and delete the originals, making the critical data unavailable to be used till the ransom amount asked is paid (Gazet, 2010; Richardson & North, 2017). Ransomware related attacks on various healthcare institutions show that the unavailable systems and patient data are real threats and could cause serious harm (Bhuyan et al., 2020; Ross, 2017) and even death (Tidy, 2020).

In addition to this adoption of and reliance on technology, increased regulation, provider consolidation, and the increasing need for information exchange between patients, providers and payers, all point towards the need for better information security in healthcare (Appari & Johnson, 2010), encompassing confidentiality, integrity, and availability (CIA) of systems and data (Bertino & Sandhu, 2005). Several standards, frameworks, and guides applicable to the healthcare industry aim to implement these information security-related goals focusing on privacy and safety. The CIA triad is positioned at the heart of various security governance standards and codes of practice were adopted by public, private, and non-governmental organizations, including healthcare (Samonas & Coss, 2014). The BS7799 information security standards, which eventually have been incorporated in the ISO 27000 family of standards, have initially provided the foundations for comprehensive and more manageable approaches for information security in healthcare using the CIA triad (Tong, Fung, Huang, & Chan, 2003). ISO/IEC 27001 helps healthcare organizations protect their information and comply with a series of laws and regulations. The standard specifies the requirements for establishing, implementing, maintaining, and continually improving an information security management system within the organization's context (Achmadi, Suryanto, & Ramli, 2018). It is generic and intended to apply to all organizations, regardless of the type, size, or nature (ISO-27001, 2013). ISO 27002 provides guidelines for selecting, implementing, and managing commonly accepted controls for ISO 27001 (ISO-27002, 2013). ISO 27799 defines guidelines to support the interpretation and implementation in health informatics of ISO 27002 and is a companion to ISO 27002 (ISO-27799, 2016).

In healthcare, quality medical care can be interpreted as the capacity of the elements of that care to achieve legitimate medical and non-medical goals (Steffen, 1988). The high quality of care allows appropriate care to patients, achieves positive clinical outcomes, avoids unnecessary clinical complications, and ensures resources are used efficiently (Kunkel & Westerling, 2006). Although structure, process, and outcome (Donabedian, 1966) remain central to measuring and improving quality, the current emphasis of quality is on patient centeredness, the new information age and its profound impact on risks and possibilities for care and health, and the healthcare as a system (Berwick & Fox, 2016). Quality is now playing a more critical role as patients have started choosing healthcare providers based on the quality of care and their level of satisfaction with the organization from their previous experiences (Harris & Buntin, 2008). A patient can now access more information on healthcare providers and make more informed choices about their treatment. Both quality management and information security management systems share common elements such as integrating and modularizing same or similar functions such as document and record controls, corrective and preventive means, internal audits and reviews, and most importantly, the Plan Do Check Act (PDCA) (Aggarwal, Aeran, & Rathee, 2019; Gaivéo, 2016) management cycle. A Quality and Information Security Management (QISM) approach focused on the PDCA cycle allows healthcare organizations to manage and protect their information assets, including patient data, effectively and efficiently and deliver better healthcare services (Aggarwal et al., 2019).

Safety and quality are generally dependent on each other, and safety is mainly presented as one quality dimension. This view received more acceptance after the Institute of Medicine report 'To Err is Human' putting safety to the forefront and describing it as the first quality dimension (Kohn, Corrigan, & Donaldson, 2000). Managing and improving the quality, cost, delivery, safety, and environment of management elements are common issues in the healthcare industry. Because almost all the industry tasks relate to human life, safety is a more critical element in healthcare compared to other industries (Munechika, Sano, Jin, & Kajihara, 2014). It is also considered the most critical and defining factor for patients (Vincent, 2010). A culture of safety is the shared values, attitudes, perceptions, and patterns of behavior that determine the observable degree of effort with which all organizational members direct their attention and actions towards minimizing patient harm that may result from the process of care delivery (Vogus & Sutcliffe, 2007). Patient safety climate is an important work environment factor determining patient safety and quality of care in healthcare organizations (Ausserhofer et al., 2013). Embracing patient harm prevention and the importance of a strong culture of safety in healthcare organizations is a central tenet to improve and drive patient safety and quality of care (Singer et al., 2009; Wachter, 2012).

Various individual studies have focused on approaches and outcomes of patient safety climate, quality management, and information security within healthcare impacting patients. However, there is minimal research that emphasizes the impact due to the interactions among these approaches. This quantitative study aims to determine the functional relationships among information security, patient safety climate, and quality management dimensions within a healthcare system. The main research question is: "Is there a relationship between QISM and patient safety climate?" This question is answered by evaluating these three critical dimensions' influence and their components on healthcare excellence by conducting a survey based on standards and frameworks in a state university training and research hospital.

2. Method

2.1. Population and Sample

For this study, a state university training and research hospital was chosen for the sample data collection. Research hospitals emphasize patient safety, quality, and information security-related measures due to their focus on research programs and policies (Jalali & Kaiser, 2018). These programs and policies aim to provide innovations, good care service, and obtain the best results through viable investments. The university hospital having the accredited standards implemented responded and accepted our survey request regarding the topics mentioned. The University Healthcare Research and Application Center gave ethical permission for the research.

The total number of people working for the hospital was 2433. As one of the study's critical areas was information security, the university's information technology (IT) department was our main point of contact. Our population for the survey was all staff who had valid user accounts utilizing hospital information systems and applications. The questionnaires were distributed to 700 users. Six categories were formed to represent the general participant profiles as part of the demographics for data processing purposes. These profiles represented the characteristics of the population profile. The six categories were: 1=Nurse, 2=Physician, 3=Medical Assistant, 4=Technicians, 5=Administrative Assistants, 6=IT Staff.

2.2. Measures

There are many instruments to analyze safety culture and climate. Sexton and colleagues developed a safety climate scale (SCS) for healthcare organizations (Shteynberg, Sexton, & Thomas, 2005). Patient safety-related items were formed based on SCS and Safety Attitudes Questionnaire (John B Sexton et al., 2006), which improved the Intensive Care Unit Management Attitudes Questionnaire (J Bryan Sexton, Thomas, & Helmreich, 2000; Thomas, Sexton, & Helmreich, 2003). The validity and reliability of the SCS also have been supported by previous research (Tütüncü & Küçükusta, 2008). However, there is no specific scale to measure QISM for healthcare organizations. For evaluations within the context of this research, the views of various experts were taken into consideration. According to previous research, standards, and the comments of specialists, a scale of QISM was developed. The quality related items of this scale were based on established quality related research (Tutuncu, Camsari, Cavdar, & Kiremitci, 2009). Information security related items were formed using prior studies (Upfold & Sewry, 2005; Yeniman Yildirim, Akalp, Aytac, & Bayram, 2011) that validated information security dimensions and ISO/IEC 27001 Information Security Management System (ISO-27001, 2005) objectives and clauses.

The complete survey consisted of three parts. Within the first part, the safety climate was adapted and measured by a 19 item SCS. A five-point interval scale ranging from 1 = Never 5 = Always was used to measure the items to assess safety climate. In the second part of the survey, QISM was measured by 27 items. Items used to assess quality and information management system construct were also measured on a five-point interval scale ranging from 1 = Never to 5 = Always. The third and the last part presented demographic questions about the respondents such as gender, age, education, and departments.

2.3. Data collection, participants, and procedures

For data collection, the questionnaire methodology was preferred as it was reliable, economical, and straightforward. The data were obtained through structured surveys based on current standards and methodological frameworks regarding the critical dimensions. The final version of the questionnaire was distributed to the staff in clinical and service departments of the hospital, along with the proper authorization forms indicating management's approval to ensure the study's formality. For timely responses and better participation, questionnaires were distributed simultaneously to each department via their departmental supervisor (face to face) or via inter-office mail. To ensure high participation and accurate responses, participants were asked not to provide any identification information. The finished questionnaires were collected in batches and returned to us for data processing. With a response rate of 58%, 411 surveys were collected from all the departments. After the scanning process, 22 surveys were excluded due to missing data, and in total 389 surveys, 55% were accepted and processed for statistical analysis.

2.4. Statistical analysis

The data obtained were analyzed by using SPSS 19 software. Within the scope of descriptive statistics, qualitative variables are presented by frequency tables. ML factoring was applied in the study to measure the construct validity of scales. The reliability (Cronbach's alpha) of QISM and safety climate was tested. Canonical correlation analysis was conducted to determine the relationship between QISM and safety climate.

3. Results

Demographic dispersion and profile of respondents were stated in table 1. The skewness and kurtosis values were well within the acceptable range for a normal distribution. Examination of the histograms also confirmed the normality.

Table 1. Numerical and percentage dispersion of sample profile

		Overall		Female		Male	
		N	%	N	%	N	%
Job class							
	Nurse	122	36.53	112	91.80	10	8.20
	Physician	60	17.96	28	46.67	32	53.33
	Medical Assistant	68	20.36	54	79.41	14	20.59
	Technician	40	11.98	21	52.50	19	47.50
	Administrative Assistant	32	9.58	14	43.75	18	56.25
	IT Staff	12	3.59	3	25.00	9	75.00
	Total	334	100.00	232	69.46	102	30.54
Age							
	<20	10	2.63	8	80.00	2	20.00
	21-29	161	42.37	115	71.43	46	28.57
	30-39	164	43.16	115	70.12	49	29.88
	40-49	40	10.53	23	57.50	17	42.50
	>50	5	1.32	1	20.00	4	80.00
	Total	380	100.00	262	68.95	118	31.05
Education							
	High School	71	18.88	47	66.20	24	33.80
	Associate	83	22.07	56	67.47	27	32.53
	Undergraduate	160	42.55	120	75.00	40	25.00
	Graduate	62	16.49	37	59.68	25	40.32
	Total	376	100.00	260	69.15	116	30.85
Years worked							
	<1	38	10.03	22	57.89	16	42.11
	1-5	151	39.84	102	67.55	49	32.45
	6-10	113	29.82	84	74.34	29	25.66
	11-20	70	18.47	49	70.00	21	30.00
	>21	7	1.85	4	57.14	3	42.86
	Total	379	100.00	261	68.87	118	31.13

The construct of healthcare services is complex, and it can affect the safety and quality of climate. ML can be performed to measure the unique and common variances when data are normally distributed (Fabrigar, Wegener, MacCallum, & Strahan, 1999). Common approaches are more important than unique approaches for teamwork in these organizations. Therefore, ML factoring was chosen for finding the dimensions of QISM and safety climate. In order to find the number of factors in exploratory factor analysis, Cattell's (1966) scree test and Velicer's (1976) minimum average partial test with syntax (O’connor, 2000) were carried out on the data. Both test results showed a two-factor solution for SCS and a three-factor solution for QISM for extraction.

ML factoring results showed that factor correlations were higher than 0.69 and lower than 0.80 for dimensions of QISM. The correlation was 0.73 for two dimensions of SCS. Because of nonorthogonal factors, the promax oblique solution was used for both rotations. Bartlett's sphericity test was significant ($p < 0.001$), and Kaiser–Meyer–Olkin measure of sampling adequacy value was .97 for QISM. Bartlett's test of sphericity was also significant ($p<0.001$), and Kaiser–Meyer–Olkin measure of sampling adequacy value as 0.94 for SCS. Both of them were above the suggested value of 0.60 (J. Hair, Money, Samouel, & Page, 2007). Preliminary examination of the data showed that factor analysis was suitable for both scales.

All items from the factor analysis resulted in two-factor groupings and explained 48.5 % of the common (shared) variance for SCS. Results showed that safety climate had two dimensions; organizational safety climate and departmental safety climate (see table 2).

Table 2 Factor analysis results for safety climate

Factors	Factor Loading	Eigen-value	Variance Explained
Factor 1 – Organizational safety climate		8.81	43.87
My suggestions about safety would be acted upon if I expressed them to management	0.972		
The senior leaders in my hospital listen to me and care about my concerns	0.905		
The physician and nurse leaders in my areas listen to me and care about my concerns	0.766		
I receive appropriate feedback about my performance	0.733		
Briefings are common here	0.658		
I would feel safe being treated here as a patient	0.635		
Leadership is driving us to be a safety-centered institution	0.616		
I believe that most adverse events occur as a result of multiple system failures and are not attributable to one individual's actions	0.482		
Management/leadership does not knowingly compromise safety concerns for productivity	0.479		
Factor 2 – Departmental safety climate		1.50	4.68
Briefing personnel before the start of a shift (i.e., to plan for possible contingencies) is an important part of safety	0.676		
The culture of this clinical area makes it easy to learn from the mistakes of others	0.675		
Patient safety is continuously reinforced as the priority in this clinical area	0.669		
I am encouraged by my colleagues to report any safety concerns I may have	0.502		
Personnel frequently disregard rules or guidelines that are established for this clinical area	0.496		
I know the proper channels to direct questions regarding patient safety	0.482		
I am satisfied with the availability of clinical leadership	0.443		
The personnel in this clinical area take responsibility for patient safety	0.433		
This institution is doing more for patient safety now than it did one year ago	0.431		
Medical errors are handled appropriately in this clinical area	0.362		

ML factoring also resulted in three-factor groupings and explained approximately 67% of the common (shared) variance for QISM. Results showed that QISM had three dimensions; quality management, information security, and general requirements (see table 3). Minimum factor loadings were above the recommended value of 0.30 (Tabachnick, Fidell, & Osterlind, 2001) and no item was eliminated from both scales.

Table 3. Factor analysis results for QISM

Factors	Factor Loading	Eigen-value	Variance Explained
Factor 1 – Quality management		16.58	60.20
Management can plan for the future and take the proper actions	0.869		
Proper infrastructure is provided for quality service	0.858		
Services are improved based on the findings	0.846		
Proper working conditions are provided for quality service	0.813		
Services are delivered according to plans	0.792		
Management provides the settings for authority, responsibility, and communication	0.786		
Experienced staff exists for a quality service	0.711		
Services provided are evaluated	0.656		
Outcomes are controlled and analyzed	0.643		
Services and procedures are provided in coordination	0.640		
Services provided are sufficient	0.635		
Management is patient-centric	0.575		
Management fulfills its responsibilities	0.487		
Factor 2 – Information security		1.34	3.64
Information systems acquisitions, development, and maintenance are handled according to policies	0.930		
Information security related incidents are handled according to the specific responsibilities and procedures	0.928		
Access control policy ensures authorized access and prevents unauthorized access to information systems	0.791		
Communications and operations management related procedures and responsibilities are well defined	0.767		
Business continuity plans are developed and implemented to avoid interruptions to business activities	0.732		
Information systems security policies comply according to the standards and legal requirements	0.702		
Physical and environmental security measures of the information systems are in place	0.686		
In our institution, Inventory, ownership, and acceptable use of assets are managed according to policies	0.671		
Personnel fulfill their responsibilities according to the information security policies and procedures	0.660		
In our institution, the organization of information security is coordinated and properly handled	0.506		
In our institution, work is handled according to a documented up-to-date information security policy	0.402		
Factor 3 – General requirements		1.13	3.25
Appropriate records are maintained properly for our services	0.971		
Definitions for care services are documented	0.738		
Quality requirements are determined towards our services	0.657		

Composite scores were calculated for each of the factors based on the mean of the items. The reliability tests were conducted on data for internal consistency. The general Cronbach's alpha of both QISM and safety climate were over the suggested value of 0.70 for reliability analysis (Nunnally, 1967). Descriptive statistics, correlations, and reliability analysis of five dimensions are shown in table 4.

Table 4. Descriptive statistics and reliability analysis

Variables	1	2	3	4	5
1. Organizational safety climate	1				
2. Departmental safety climate	0.73*	1			
3. Quality management	0.73*	0.74*	1		
4. Information security	0.67*	0.69*	0.85*	1	
5. General requirements	0.53*	0.69*	0.71*	0.72*	1
Means	3.32	3.94	3.66	3.78	4.05
Standard deviation	0.92	0.71	0.88	0.83	0.87
Cronbach's alpha	0.90	0.86	0.96	0.96	0.88

The skewness and kurtosis values of predictor variables showed that the data were normally distributed and met the homogeneity assumptions of variance and linearity. Multicollinearity of both sets' predictor variables has been checked using the variance inflation factor (VIF). VIF values (1.00 to 3.63) were below the suggested maximum VIF value of five (Rogerson, 2001).

Canonical correlation analysis was conducted using the five predictor variables (i.e., organizational safety climate, departmental safety climate, quality management, information security, and general requirements) to evaluate the multivariate shared relationship between QISM and safety climate. The analysis produced two significant functions with squared canonical correlations (R_c^2) of 0.65 and 0.09. The overall chi-square tests were significant (R_c = 0.804, $p < 0.001$ for the first function; R_c = 0.306, $p < 0.001$ for the second function). However, the unexplained variance was 32% for the first function, and it was about 91% for the second function according to Wilks' Lambda scores. In other words, the effect size was 0.68 for the first function, indicating that 68% of the variance shared between the two variable sets. The second function indicated low squared canonic correlation and effect size (R_c^2 = 0.09) even it was significant. The redundancy analysis provided adequacy coefficients and redundancies for both functions. All the proportions of variances (adequacy coefficients) for the second function were lower than 0.14. The first canonical function was accepted according to redundancy and chi-square analyses. The results of the first function were shown in table 5.

Table 5. Results of the canonical correlation analysis for the first function

Variables-Variates	Standardized canonical loadings (β)	Canonical cross loadings (R_c)	Adequacy coefficients for set 1	Adequacy coefficients for set 2
1. Safety climate			0.86	0.56
Organizational safety climate	0.44	0.73		
Departmental safety climate	0.63	0.77		
2. QISM			0.53	0.82
Quality management	0.66	0.79		
Information security	0.19	0.73		
General requirements	0.22	0.66		

Results revealed the adequacy of the variables. The full model of canonical correlation of QISM and safety climate was shown in figure 1.

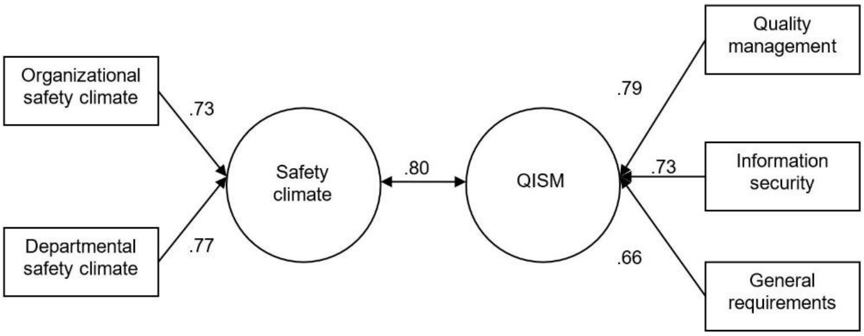

Figure 1. The model of canonical correlation

Canonical cross-loadings give a more accurate and direct measure of the dependent–independent variable relationships by eliminating an intermediate step involved in conventional loadings (J. F. Hair, Andershon, Tatham, & Black, 1998). The entire cross loadings (shared variances) and correlations among the variables were over 0.66. Regarding the predictor variables, organizational safety and departmental safety were the strong contributors to the safety climate as a synthetic predictor variable. The cross loadings of quality management, information security, and general requirements had the same sign. They were all positively correlated with QISM as another synthetic variable. Furthermore, the results indicated that there was a significant and positive relationship between QISM and safety climate.

4. Discussion

Institute of Medicine (IOM) proposes six specific goals for improvement to achieve efficiency and effectiveness within healthcare. IOM states that healthcare should be: "*safe, effective, patient centered, timely, efficient, and equitable*" (Institute of Medicine, 2001, p. 6). Information security management, quality management, and patient safety climate all play crucial roles in addressing these properties defined by IOM (Meeks, Takian, Sittig, Singh, & Barber, 2013; Runciman et al., 2006; Singh et al., 2010). Additionally, Agency for Healthcare Research and Quality funded a new model which applies systems engineering and human factors to patient safety (Howe, Butler, Kim, & Kellogg, 2020). This model focuses on to do the right thing and decrease the errors while it highlights the importance of systems engineering for patient safety. Therefore, information management has a key role to ensure patient safety, and the overall security and safety of the system cannot be ignored.

Patient safety climate has become an important subject matter being researched extensively regarding the overall satisfaction of healthcare services (Fatima, Malik, & Shabbir, 2018; Ferrand et al., 2016; Ghahramanian, Rezaei, Abdullahzadeh, Sheikhalipour, & Dianat, 2017; Mazurenko, Richter, Kazley, & Ford, 2019). There have been some quality and information security-focused studies undertaken within healthcare services research (Kisekka & Giboney, 2018; Kotz, Gunter, Kumar, & Weiner, 2016; Kuo, 2018; Shrestha, Alsadoon, Prasad, Hourany, & Elchouemi, 2016). Additionally, there is research, which emphasizes the information management systems have benefits on patient safety (Choudhury & Asan, 2020; Pfeiffer, Zimmermann, & Schwappach, 2021; Sittig et al., 2020). However, there is no empirical evidence indicating the relationship between QISM and patient safety in healthcare. This study was focused on the overall relationship between QISM and safety climate within healthcare services, and the relationship was analyzed using canonical correlation.

A strong positive relationship between QISM and safety climate is presented as two synthetic variables. In other words, any efforts made to improve QISM may also improve and contribute to the safety climate. Conversely, any safety climate improvements towards patient safety may positively affect QISM, or any negative change may impact the other in a negative direction. It is desired to take a proactive approach in order to eliminate potential risks to patient safety in health institutions (Sittig et al., 2020) and it was found that engineering tools will come forefront to improve quality of services in the future (de Sene Pereira & Broday, 2021), especially to improve patient safety. The strong relationship between quality and patient safety may be a proactive approach of the quality. Additionally, errors can be prevented automatically before they occur by an information management system integrated with the quality systems. (Murphy et al., 2018). Quality 4.0 technologies have the capacity of maintaining quality throughout the processes (Broday, 2022). Overall, Quality 4.0 helps to obtain detailed documentation in every step of the process in real-time (Li, Fast-Berglund, & Paulin, 2019). In an organization that culturally supports patient safety, detailed documentation is required to ensure a safe system that has the priority to not harm and to protect patients from errors and mistakes. Nevertheless, while gaining benefits from information management systems, disregarding the information security systems may cause additional adverse events.

The redundancy analysis of the study provided similar results. While the two dimensions of safety climate had a very strong positive relationship, these two dimensions had a positive relationship with QISM. In other words, although the dimensions were independent of each other, they still affected each other. A similar observation could be made among the three dimensions of the QISM. There were strong relationships among these three dimensions of QISM. There was also a relationship between these three dimensions and safety climate. High redundancy of dimensions of safety climate suggested high ability to predict QISM, and/or high redundancy of dimensions of QISM suggested high ability to predict safety climate.

The dimensions obtained from the QISM and safety climate via factor analysis allowed us to do a canonical correlation analysis, which provided a reasonable explanation for the overall model. In other words, the organizations' safety climate showed strong positive relationships with the unit and departmental safety. Quality management, information security, and general healthcare services requirements had a strong positive relationship with QISM, except for the general requirements. When the study supporting these relationships is examined, it is emphasized that efforts are made to design health information technologies that focus on improving patient safety (Sittig et al., 2020). Especially, in the quality management process, when we report the adverse events and near misses, they allow us to learn from our mistakes. These reports can be stored and analyzed by the information management systems. According to analyses results, managerial teams take decisions proactively or reactively to the events. It was known that analyzing the patient safety event reports have benefits to identify health safety hazards in information management systems (Chai, Anthony, Coiera, & Magrabi, 2013; Y. Wang, Coiera, Runciman, & Magrabi, 2017). As part of this reporting process, from the perspectives of both healthcare professionals and patients, the importance of the information security systems should be emphasized according to this study results.

The relationship between safety climate and QISM reveals the importance of using and expanding the use of information technologies for patient safety. In this way, health institutions can create learning models with the data they collect and develop a competitive advantage (Broday, 2022). These models enable the organizations to make smart decisions (Escobar, McGovern, & Morales-Menendez, 2021). This relationship also shows that these technologies are critical for sensitive issues such as effective communications and instant information sharing throughout the organization (Vo, Kongar, & Suárez-Barraza, 2020). At this point, the importance of information security systems should be emphasized for these very sensitive issues for healthcare organizations.

Limitations and suggestions for further research

This study was conducted only in a state university training and research hospital. These types of hospitals have complex structures and are large enterprises. Different results can be obtained in different healthcare settings providing services in different areas. While focused on the relationship between QISM and safety, this study utilized the variables used in international standards such as ISO 9001 and ISO 27001. Further studies can provide different and expanded results utilizing business excellence models. This research was designed as a cross-sectional analysis, and the results cannot be generalized. Longitudinal research should be planned to provide a proper QISM measurement.

5. Conclusion

In this study, we tried to determine whether there are relationships among information security, patient safety, and quality management dimensions within a healthcare system by asking the research question: "Is there a relationship between QISM and patient safety climate?".

In an increasingly interconnected IT environment, healthcare has become a target for cyberattacks with increased incidents and breaches. The risks associated with information security focusing on confidentiality, integrity, and availability of sensitive and private data might reduce healthcare services' overall benefits and positive impact. Patient safety and quality management programs also impact these outcomes. Improving quality and information security management may positively improve safety culture and patient safety climate in an increasingly complex healthcare delivery environment. Along the same lines, service improvements towards patient safety climate may also improve the QISM of healthcare services. Rather than independently taking these issues, healthcare organizations are better off handling them together with a holistic approach as patient safety is inseparable from healthcare quality and information security.

This study contributes to achieving potential health gains via focusing on safety climate, quality, and information security management in healthcare. The results of the study could be used to (a) help government and non-government organizations in healthcare establish information security management programs based on industry standards and information security frameworks, supported with quality management best practices to improve patient safety while improving compliance with laws and regulations, (b) inform future collaborations across academic and healthcare research institutions on ways to fill the gaps to reach a certain level of baseline healthcare excellence model with information security, quality, and safety as the three main supporting pillars and (c) develop competitive advantage for healthcare organizations which have established information management systems to improve patient safety.

References:

Abomhara, M. (2015). Cyber security and the internet of things: vulnerabilities, threats, intruders and attacks. *Journal of Cyber Security and Mobility, 4*(1), 65-88.

Achmadi, D., Suryanto, Y., & Ramli, K. (2018). *On developing information security management system (isms) framework for iso 27001-based data center.* Paper presented at the 2018 International Workshop on Big Data and Information Security (IWBIS).

Aggarwal, A., Aeran, H., & Rathee, M. (2019). Quality management in healthcare: The pivotal desideratum. *Journal of oral biology and craniofacial research, 9*(2), 180-182.

Amendola, S., Lodato, R., Manzari, S., Occhiuzzi, C., & Marrocco, G. (2014). RFID technology for IoT-based personal healthcare in smart spaces. *IEEE Internet of things journal, 1*(2), 144-152.

Appari, A., & Johnson, M. E. (2010). Information security and privacy in healthcare: current state of research. *International journal of Internet and enterprise management, 6*(4), 279-314.

Ausserhofer, D., Schubert, M., Desmedt, M., Blegen, M. A., De Geest, S., & Schwendimann, R. (2013). The association of patient safety climate and nurse-related organizational factors with selected patient outcomes: a cross-sectional survey. *International Journal of Nursing Studies, 50*(2), 240-252.

Babar, S., Mahalle, P., Stango, A., Prasad, N., & Prasad, R. (2010). *Proposed security model and threat taxonomy for the Internet of Things (IoT).* Paper presented at the International Conference on Network Security and Applications.

Bertino, E., & Sandhu, R. (2005). Database security-concepts, approaches, and challenges. *IEEE transactions on dependable and secure computing, 2*(1), 2-19.

Berwick, D., & Fox, D. M. (2016). “Evaluating the quality of medical care”: Donabedian's classic article 50 years later. *The Milbank Quarterly, 94*(2), 237.

Bhuyan, S. S., Kabir, U. Y., Escareno, J. M., Ector, K., Palakodeti, S., Wyant, D., . . . Dasgupta, D. (2020). Transforming healthcare cybersecurity from reactive to proactive: current status and future recommendations. *Journal of medical systems, 44*, 1-9.

Broday, E. E. (2022). The evolution of quality: From inspection to quality 4.0. *International Journal of Quality and Service Sciences*.

Cattell, R. B. (1966). The Scree Test For The Number Of Factors. *Multivariate Behavioral Research, 1*(2), 245-276. doi:10.1207/s15327906mbr0102_10

Chai, K. E., Anthony, S., Coiera, E., & Magrabi, F. (2013). Using statistical text classification to identify health information technology incidents. *Journal of the American Medical Informatics Association, 20*(5), 980-985.

Choudhury, A., & Asan, O. (2020). Role of artificial intelligence in patient safety outcomes: systematic literature review. *JMIR medical informatics, 8*(7), e18599.

Cockburn, I. M., Henderson, R., & Stern, S. (2018). *The impact of artificial intelligence on innovation* (0898-2937). Retrieved from

Couturier, J., Sola, D., Borioli, G., & Raiciu, C. (2012). How can the internet of things help to overcome current healthcare challenges. *Communications & Strategies*(87), 67-81.

Da Xu, L., He, W., & Li, S. (2014). Internet of things in industries: A survey. *IEEE Transactions on industrial informatics, 10*(4), 2233-2243.

Davis, J. (2020). 41 Providers Reported Ransomware Attacks in First Half of 2020. Retrieved from https://healthitsecurity.com/news/41-providers-reported-ransomware-attacks-in-first-half-of-2020

de Sene Pereira, N. N., & Broday, E. E. (2021). Applıcatıon of control charts for monıtorıng the waıtıng tıme ın a basıc healthcare unıt ın Brazıl. *International Journal for Quality Research, 15*(3), 1007.

Donabedian, A. (1966). Evaluating the quality of medical care. *The Milbank memorial fund quarterly, 44*(3), 166-206.

Escobar, C. A., McGovern, M. E., & Morales-Menendez, R. (2021). Quality 4.0: a review of big data challenges in manufacturing. *Journal of Intelligent Manufacturing, 32*(8), 2319-2334.

Fabrigar, L. R., Wegener, D. T., MacCallum, R. C., & Strahan, E. J. (1999). Evaluating the use of exploratory factor analysis in psychological research. *Psychological methods, 4*(3), 272.

Fatima, T., Malik, S. A., & Shabbir, A. (2018). Hospital healthcare service quality, patient satisfaction and loyalty. *International Journal of Quality & Reliability Management*.

Fernandez, F., & Pallis, G. C. (2014). *Opportunities and challenges of the Internet of Things for healthcare: Systems engineering perspective.* Paper presented at the 2014 4th International Conference on Wireless Mobile Communication and Healthcare-Transforming Healthcare Through Innovations in Mobile and Wireless Technologies (MOBIHEALTH).

Ferrand, Y. B., Siemens, J., Weathers, D., Fredendall, L. D., Choi, Y., Pirrallo, R. G., & Bitner, M. (2016). Patient satisfaction with healthcare services a critical review. *Quality Management Journal, 23*(4), 6-22.

Flavián, C., Ibáñez-Sánchez, S., & Orús, C. (2019). The impact of virtual, augmented and mixed reality technologies on the customer experience. *Journal of Business Research, 100*, 547-560.

Freeman, D., Reeve, S., Robinson, A., Ehlers, A., Clark, D., Spanlang, B., & Slater, M. (2017). Virtual reality in the assessment, understanding, and treatment of mental health disorders. *Psychological medicine, 47*(14), 2393-2400.

Gaivéo, J. (2016). Information Security Standards in Healthcare Activities. *International Journal of Reliable and Quality E-Healthcare (IJRQEH), 5*(4), 15-33.

Gazet, A. (2010). Comparative analysis of various ransomware virii. *Journal in computer virology, 6*(1), 77-90.

Ghahramanian, A., Rezaei, T., Abdullahzadeh, F., Sheikhalipour, Z., & Dianat, I. (2017). Quality of healthcare services and its relationship with patient safety culture and nurse-physician professional communication. *Health promotion perspectives, 7*(3), 168.

Golub, T. R., Slonim, D. K., Tamayo, P., Huard, C., Gaasenbeek, M., Mesirov, J. P., . . . Lander, E. S. (1999). Molecular Classification of Cancer: Class Discovery and Class Prediction by Gene Expression Monitoring. *Science, 286*(5439), 531-537. doi:10.1126/science.286.5439.531

Hair, J., Money, A. H., Samouel, P., & Page, M. (2007). *Research methods for business* (Vol. 613): John Wiley & Son Ltd.

Hair, J. F., Andershon, R. E., Tatham, R. L., & Black, W. C. (1998). Multivariate Data Analysis. In: Prentice Hall.

Harris, K., & Buntin, M. (2008). Choosing a health care provider: the role of quality information. *Policy, 1*(6).

Hassanalieragh, M., Page, A., Soyata, T., Sharma, G., Aktas, M., Mateos, G., . . . Andreescu, S. (2015). *Health monitoring and management using Internet-of-Things (IoT) sensing with cloud-based processing: Opportunities and challenges.* Paper presented at the 2015 IEEE International Conference on Services Computing.

Howe, J. L., Butler, R. L., Kim, T. C., & Kellogg, K. M. (2020). Addressing adverse events in health care through a safety science lens. In *Clinical Engineering Handbook* (pp. 865-870): Elsevier.

Hughes, R. G., & Blegen, M. A. (2008). Medication administration safety. In *Patient safety and quality: An evidence-based handbook for nurses*: Agency for Healthcare Research and Quality (US).

Institute of Medicine. (2001). *Crossing the quality chasm: A new health system for the 21st century*. Washington, D.C.: The National Academies Press.

ISO-27001. (2005). ISO/IEC 27001:2005 – Information technology – Security techniques – Information security management systems – Requirements. In: ISO.

ISO-27001. (2013). ISO/IEC 27001:2013 Information technology — Security techniques — Information security management systems — Requirements. In.

ISO-27002. (2013). ISO/IEC 27002:2013 Information technology — Security techniques — Code of practice for information security controls. In.

ISO-27799. (2016). ISO 27799:2016 Health informatics — Information security management in health using ISO/IEC 27002. In.

Jalali, M. S., & Kaiser, J. P. (2018). Cybersecurity in hospitals: a systematic, organizational perspective. *J Med Internet Res, 20*(5), e10059.

Jha, S., & Topol, E. J. (2016). Adapting to Artificial Intelligence: Radiologists and Pathologists as Information Specialists. *JAMA, 316*(22), 2353-2354. doi:10.1001/jama.2016.17438

Jiang, F., Jiang, Y., Zhi, H., Dong, Y., Li, H., Ma, S., . . . Wang, Y. (2017). Artificial intelligence in healthcare: past, present and future. *Stroke and Vascular Neurology, 2*(4), 230-243. doi:10.1136/svn-2017-000101

Kisekka, V., & Giboney, J. S. (2018). The effectiveness of health care information technologies: evaluation of trust, security beliefs, and privacy as determinants of health care outcomes. *J Med Internet Res, 20*(4), e107.

Kohn, L. T., Corrigan, J. M., & Donaldson, M. S. (2000). *To Err Is Human: Building a Safer Health System*. Washington, D.C.: The National Academies Press.

Koop, C. E., Mosher, R., Kun, L., Geiling, J., Grigg, E., Long, S., . . . Rosen, J. M. (2008). Future delivery of health care: Cybercare. *IEEE Engineering in Medicine and Biology Magazine, 27*(6), 29-38.

Kotz, D., Gunter, C. A., Kumar, S., & Weiner, J. P. (2016). Privacy and security in mobile health: a research agenda. *Computer, 49*(6), 22-30.

Kunkel, S. T., & Westerling, R. (2006). Different types and aspects of quality systems and their implications: A thematic comparison of seven quality systems at a university hospital. *Health Policy, 76*(2), 125-133.

Kuo, R.-Z. (2018). EMRS Adoption: Exploring the effects of information security management awareness and perceived service quality. *Health Policy and Technology, 7*(4), 365-373.

Lee, J., Suh, T., Roy, D., & Baucus, M. (2019). Emerging Technology and Business Model Innovation: The Case of Artificial Intelligence. *Journal of Open Innovation: Technology, Market, and Complexity, 5*(3), 44.

Li, D., Fast-Berglund, Å., & Paulin, D. (2019). Current and future Industry 4.0 capabilities for information and knowledge sharing. *The International Journal of Advanced Manufacturing Technology, 105*(9), 3951-3963.

Lin, C.-F. (2012). Mobile telemedicine: A survey study. *Journal of medical systems, 36*(2), 511-520.

Martínez-Pérez, B., De La Torre-Díez, I., & López-Coronado, M. (2013). Mobile health applications for the most prevalent conditions by the World Health Organization: review and analysis. *J Med Internet Res, 15*(6), e120.

Martínez-Pérez, B., De La Torre-Díez, I., & López-Coronado, M. (2015). Privacy and security in mobile health apps: a review and recommendations. *Journal of medical systems, 39*(1), 181.

Mazurenko, O., Richter, J., Kazley, A. S., & Ford, E. (2019). Examination of the relationship between management and clinician perception of patient safety climate and patient satisfaction. *Health care management review, 44*(1), 79-89.

Meeks, D. W., Takian, A., Sittig, D. F., Singh, H., & Barber, N. (2013). Exploring the sociotechnical intersection of patient safety and electronic health record implementation. *Journal of the American Medical Informatics Association, 21*(e1), e28-e34. doi:10.1136/amiajnl-2013-001762

Munechika, M., Sano, M., Jin, H., & Kajihara, C. (2014). Quality management system for health care and its effectiveness. *Total Quality Management & Business Excellence, 25*(7-8), 889-896.

Murphy, D. R., Meyer, A. N., Vaghani, V., Russo, E., Sittig, D. F., Wei, L., . . . Singh, H. (2018). Electronic triggers to identify delays in follow-up of mammography: harnessing the power of big data in health care. *Journal of the American College of Radiology, 15*(2), 287-295.

Nunnally, J. C. (1967). *Psychometric theory*. New York: McGraw-Hill New York.

O'connor, B. P. (2000). SPSS and SAS programs for determining the number of components using parallel analysis and Velicer's MAP test. *Behavior research methods, instruments, & computers, 32*(3), 396-402.

Pfeiffer, Y., Zimmermann, C., & Schwappach, D. L. (2021). Patient Safety Threats in Information Management Using Health Information Technology in Ambulatory Cancer Care: An Exploratory, Prospective Study. *Journal of Patient Safety, 17*(8), e1793-e1799.

Richardson, R., & North, M. M. (2017). Ransomware: Evolution, mitigation and prevention. *International Management Review, 13*(1), 10.

Rogerson, P. (2001). *Statistical methods for geography*. London: Sage.

Ross, J. (2017). Cybersecurity: A real threat to patient safety. *Journal of PeriAnesthesia Nursing, 32*(4), 370-372.

Runciman, W., Williamson, J., Deakin, A., Benveniste, K., Bannon, K., & Hibbert, P. (2006). An integrated framework for safety, quality and risk management: an information and incident management system based on a universal patient safety classification. *BMJ quality & safety, 15*(suppl 1), i82-i90.

Samonas, S., & Coss, D. (2014). THE CIA STRIKES BACK: REDEFINING CONFIDENTIALITY, INTEGRITY AND AVAILABILITY IN SECURITY. *Journal of Information System Security, 10*(3).

Sexton, J. B., Helmreich, R. L., Neilands, T. B., Rowan, K., Vella, K., Boyden, J., . . . Thomas, E. J. (2006). The Safety Attitudes Questionnaire: psychometric properties, benchmarking data, and emerging research. *BMC health services research, 6*(1), 44. doi:10.1186/1472-6963-6-44

Sexton, J. B., Thomas, E. J., & Helmreich, R. L. (2000). Error, stress, and teamwork in medicine and aviation: cross sectional surveys. *British Medical Journal, 320*(7237), 745-749.

Shrestha, N., Alsadoon, A., Prasad, P., Hourany, L., & Elchouemi, A. (2016). *Enhanced e-health framework for security and privacy in healthcare system.* Paper presented at the 2016 Sixth International Conference on Digital Information Processing and Communications (ICDIPC).

Shteynberg, G., Sexton, J. B., & Thomas, E. J. (2005). *Test Retest Reliability of the Safety Climate Scale*. Retrieved from The University of Texas Center of Excellence for Patient Safety Research and Pracitice: http://www.utpatientsafety.org

Singer, S. J., Gaba, D. M., Falwell, A., Lin, S., Hayes, J., & Baker, L. (2009). Patient safety climate in 92 US hospitals: differences by work area and discipline. *Medical care*, 23-31.

Singh, H., Thomas, E. J., Sittig, D. F., Wilson, L., Espadas, D., Khan, M. M., & Petersen, L. A. (2010). Notification of abnormal lab test results in an electronic medical record: do any safety concerns remain? *The American Journal of Medicine, 123*(3), 238-244.

Sittig, D. F., Wright, A., Coiera, E., Magrabi, F., Ratwani, R., Bates, D. W., & Singh, H. (2020). Current challenges in health information technology–related patient safety. *Health informatics journal, 26*(1), 181-189.

Steffen, G. E. (1988). Quality medical care: a definition. *JAMA, 260*(1), 56-61.

Tabachnick, B. G., Fidell, L. S., & Osterlind, S. J. (2001). Using multivariate statistics.

Tarouco, L. M. R., Bertholdo, L. M., Granville, L. Z., Arbiza, L. M. R., Carbone, F., Marotta, M., & de Santanna, J. J. C. (2012). *Internet of Things in healthcare: Interoperatibility and security issues.* Paper presented at the 2012 IEEE International Conference on Communications (ICC).

Thibaud, M., Chi, H., Zhou, W., & Piramuthu, S. (2018). Internet of Things (IoT) in high-risk Environment, Health and Safety (EHS) industries: A comprehensive review. *Decision Support Systems, 108*, 79-95.

Thomas, E. J., Sexton, J. B., & Helmreich, R. L. (2003). Discrepant attitudes about teamwork among critical care nurses and physicians. *Critical care medicine, 31*(3), 956-959.

Tidy, J. (2020). Police launch homicide inquiry after German hospital hack. Retrieved from https://www.bbc.com/news/technology-54204356

Tong, C. K., Fung, K., Huang, H. Y., & Chan, K. K. (2003). *Implementation of ISO17799 and BS7799 in picture archiving and communication system: local experience in implementation of BS7799 standard.* Paper presented at the International Congress Series.

Turcu, C. E., & Turcu, C. O. (2013). Internet of things as key enabler for sustainable healthcare delivery. *Procedia-Social and Behavioral Sciences, 73*, 251-256.

Tutuncu, O., Camsari, T., Cavdar, C., & Kiremitci, I. (2009). *Evaluating the Perceptions of Nephrology Physicians on Quality Management System in Turkey*. Paper presented at the International Symposium of Quality Management, Taipei.

Tütüncü, Ö., & Küçükusta, D. (2008). Tedarik Zinciri Entegrasyonu ve Hasta Güvenliği İlişkisinin Analizi. *Deü İşletme Fakültesi Dergisi, 9*(1), 93-106.

Upfold, C. T., & Sewry, D. A. (2005). *An investigation of information security in small and medium enterprises (SME's) in the Eastern Cape.* Rhodes University, Retrieved from http://icsa.cs.up.ac.za/issa/2005/Proceedings/Research/082_Article.pdf

Velicer, W. F. (1976). Determining the number of components from the matrix of partial correlations. *Psychometrika, 41*(3), 321-327.

Vincent, C. (2010). *Patient Safety* (2nd ed.). Oxford: BMJ Books.

Vo, B., Kongar, E., & Suárez-Barraza, M. F. (2020). Root-cause problem solving in an Industry 4.0 context. *IEEE Engineering Management Review, 48*(1), 48-56.

Vogus, T. J., & Sutcliffe, K. M. (2007). The Safety Organizing Scale: development and validation of a behavioral measure of safety culture in hospital nursing units. *Medical care*, 46-54.

Wachter, R. M. (2012). *Understanding patient safety*: McGraw Hill Medical New York.

Wang, J., Zhang, Z., Xu, K., Yin, Y., & Guo, P. (2013). A research on security and privacy issues for patient related data in medical organization system. *International Journal of Security and Its Applications, 7*(4), 287-298.

Wang, Y., Coiera, E., Runciman, W., & Magrabi, F. (2017). Using multiclass classification to automate the identification of patient safety incident reports by type and severity. *BMC Med Inform Decis Mak, 17*(1), 1-12.

Widup, S., Spitler, M., Hylender, D., & Bassett, G. (2018). *2018 Verizon Data Breach Investigations Report*. Retrieved from

Yeniman Yildirim, E., Akalp, G., Aytac, S., & Bayram, N. (2011). Factors influencing information security management in small- and medium-sized enterprises: A case study from Turkey. *International Journal of Information Management, 31*(4), 360-365. doi:http://dx.doi.org/10.1016/j.ijinfomgt.2010.10.006

Yu, K.-H., Beam, A. L., & Kohane, I. S. (2018). Artificial intelligence in healthcare. *Nature Biomedical Engineering, 2*(10), 719-731. doi:10.1038/s41551-018-0305-z

Zhang, K., Yang, K., Liang, X., Su, Z., Shen, X., & Luo, H. H. (2015). Security and privacy for mobile healthcare networks: from a quality of protection perspective. *IEEE Wireless Communications, 22*(4), 104-112.

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