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Health Information Categorization for Patient Referral in Thailand: The Perceptions of Patients and Healthcare Professionals

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Abstract

This article aimed to explore the standard set of healthcare information for patient safety and care efficiency in time and cost. Therefore, the findings will benefit the development of a management platform that may possibly be a constitutional concept to respond to the need for national healthcare data standards and lead to the standardization of healthcare information for patients' referral process. In this study, the total number of subjects was 903 participants, including 424 healthcare professionals and 479 patients or relatives. They were selected by the specific inclusion criteria, which are their experiences of healthcare services in patients' referral systems. The instrument for collecting data was a mixed-methods research methodology; quantitative and qualitative mechanisms were conducted. The statistical tools for data analysis were descriptive statistics and factor analysis. The research results were: first, the in-depth interview with healthcare professionals confirmed the commonly used information in patient referrals, including Personal Information, Medical treatment expenses, drug addiction growth, Clinical Data, Drug Utilization, Principal or Specific diagnosis, Diagnosis-related, Treatment Historical Report, Psychotherapy, HIV/AID infection, Monitor, Emergency, Symptoms/conditions, Original-Recipient Hospital details, Referral objectives, Informant, Witness details, and Data usage. Furthermore, the survey result revealed that the given 19 information categories could be condensed into three data groups: Patient-specific, Expert-based and administrative data. This research's findings will aid stakeholders, e.g., policymakers and healthcare organizations, to achieve meaningful use, facilitating the adoption and implementation of EHRs and HIE.

Keywords: Healthcare information; Patient Referral Systems; Information Sharing; Data Categorization

Introduction

Health information exchange (HIE) is defined as the electronic transfer of health-related information e.g., patient and medical information between organizations or healthcare providers, (Akhlaq et al., 2016; Esmaeilzadeh & Sambasivan, 2016). HIE possesses several benefits, including improving care coordination and healthcare quality. Furthermore, it would explicitly enhance patient safety by reducing medication and medical errors and eliminating redundant or unnecessary testing, handling, and paperwork (Dixon, 2016; Lengel et al., 2020). In addition, health information sharing between patients and their health care providers helps improve diagnoses, and therapy effectiveness also benefits society and public health. Nowadays, numerous forms of transaction for health information exchange could facilitate the accessibility and retrieval of clinical data, also securely sharing a patient's vital medical information electronically, for instance, directed exchange with accessibility and visibility to patient information between care providers to support coordinated care in patient referral systems. On the contrary, the query-based discussion could serve to deliver unplanned care. The purpose is to enhance the ability of care providers to discover or request information about patients from other persons or institutions, i.e., emergency cases (Williams et al., 2012; Ancker et al., 2012; Campion et al., 2013).

Despite the cooperative health information exchange, there are existing limitations and barriers. For example, Healthcare Information sharing seems to be asymmetric, which has been envisaged from inadequate information sharing between healthcare organizations under concerted consent management (Jermsittiparsert et al., 2019; Spanakis et al., 2021). As a result, the benefits of medical data sharing for patient care and other secondary purposes may be perceived as harmful with some patient information disclosure. The most significant ethical concerns about breaches of confidentiality have arisen in situations in which third parties are involved during the patient's referral processes. For the Healthcare industry, interoperability is critical in adopting or implementing integrated health information systems (Kondylakis et al., 2020). Considering healthcare information that needs to be shared effectively, covering its traceability to provide visibility in the healthcare system, standard practice for health information exchange would establish interoperability between various organizations and systems. As a consequence of this, collecting and storing the patients and medical data is essential in healthcare. Meanwhile, securely distributing information has become a global healthcare challenge (Bogaert et al., 2021). Therefore, the ability to access, share, a reveal should be performed with the standards, policies, and technology to initiate all forms of health information exchange.

This paper attempts to generate standard healthcare information for patients' referrals. The expected outcome is to accelerate healthcare accessibility and reduce mortality by manipulating and sharing patients' health records to increase interoperability between caregivers, hospitals, and other medical stakeholders in providing consistent medical records without infringing patients' privacy while keeping an upsurge of trust between health services providers. This paper's findings will benefit stakeholders interested e.g., policymakers in the effort to achieve meaningful use, facilitating the implementation and adoption of EHRs, and HIE.

Research Objectives

1. To explore the critical and sharable set of relevant healthcare information to treatment process between different health services providers for health service receivers' prosperity.

2. To classify the healthcare information and engender the concept of standard healthcare information sharing within patients' referral systems that will enhance healthcare accessibility and care service quality.

Literature Review

The challenges for health information exchange in Thailand

The research by Health System Research Institute (HSRI) on the HIS/eHealth situation in Thailand addresses the challenges of national Health Information System (HIS) and Health Information Technology (HIT) development in Thai health systems. It revealed the country's inadequately developed health information standards (Kijsanayotin et al., 2010). Though the government agencies are actively preparing their organization to be e-government to provide a better service, the investment in information systems and interoperability primarily related to health information standards seems insufficient (Thit et al., 2016). From the implementation of some pilot projects under e-government, the transformation has been under apathy for four main reasons: unavailable of national data standards, lack of best practices to follow, unclear guidelines for how to start and monitor the project, and there is no proactive mindset (Kawtrakul et al., 2011).

Despite the fact that health informatics professionals in Thailand have encouraged the adoption of health data standards; nonetheless, there are hindrances such as a lack of human resources in health informatics, lack of awareness, and unfamiliarity with the potential benefits of using standards and terminologies in healthcare among high-level policymakers and healthcare professionals (Thit et al., 2016). Whereas all stakeholders in the healthcare supply chain need accurate and consistent information to efficiently respond to the demand and support in both clinical and logistics activities. (Kritchanchai et al., 2019). It is important to note that the demand for healthcare information is significantly rising, especially in unforeseen and emergent circumstances. For instance, a robust set of patient identifiers supports automated patient identity matching and workflow integration in a growing epidemic (Cummins et al., 2020). According to the eHealth Strategy in Thailand, Ministry of Public Health (2017 – 2026), there is an attempt to enhance the use of computational technologies and analysis techniques, intelligent devices, and communication media to support healthcare professionals and patients on health care services and tackle the related risks management, as well as promote health and well-being. Conclusively, the lack of interoperability, improving health literacy, and health data standards remain significant challenges in Thai health information systems development.

Technical barriers to health information exchange

Technical barriers refer to different data collection and preservation standards, restrictive data formats, and technical guidelines/solutions. Besides, the complexity of EHRs and clinical IT applications would be another hurdle. For instance, the electronic health records, disease registries, clinical trial documentation, and mortality databases in different information systems could be heterogeneous, context-dependent, sometimes incomplete, or possibly incorrect (Schulz et al., 2019). While the different staffing levels, technical competency is associated with awareness and problem-solving skills. Thus, the absence of HIE involvement and evaluation would impede the process of building accountability and responsibility for the overall success of the program implementation and improving its adoption (Watkinson et al., 2021).

Healthcare organizations could theoretically perceive the benefits of information technology, and it would increase demand for an interoperable healthcare data system. However, the fact remains that inadequate investment, complex systems, and a lack of data standards with privacy protection that enable clinical data exchange are obstacles to implementing HIE practices. In addition, the essential data should display in a standard and clear view to any healthcare providers involved, irrespective of the location, person, or original affiliation.

Nonetheless, the cross-organizational collaboration of today seems not fully compliant with evidence-based, patient-centric, timely, and safe practices. For instance, data collection often becomes repetitive, and critical information is unavailable when needed. As a result, it affects the continuity of care, and patient care becomes fragmented. Worse, individuals receiving care are often under-supported in their right to access their health data. Thus, essential elements such as minimal data set, information technology architecture, and legal governance are required (Azarm et al., 2017). Furthermore, solutions such as infrastructure development, capacity building, and efficient financing have been considered and are currently at the outset of significant international initiatives (Van Panhuis et al., 2014; Keller et al., 2009). In addition, organization-specific approaches in three themes, i.e., HIE participation, HIE assessment, and coordination strategies, can help manipulate leadership, trust, commitment, and organizational culture for pursuing HIE adoption (Guerrazzi & Feldman, 2020).

The development of health information exchange in Asia

Thailand

In 2021, the recent campaign called “Health Link Program” was launched, and it aims to strengthen the health information exchange system in Thailand. Health Link has been successfully implemented and could serve over 50 hospitals in 2021. This first HIE nationwide platform is keen to improve interoperability, privacy, and security by implementing Fast Healthcare Interoperability Resources (FHIR), pseudonymization, and access control, respectively (Taechoyotin et al., 2021). After implementing Health Link Platform, the authority anticipated escalating the accessibility and visibility of health information. First and foremost, Health Link Platform will be beneficial for healthcare providers to access and retrieve health information. By extension, convenient for healthcare receivers to improve patients' experience in healthcare, particularly the service time and treatment cost. However, health information exchange in the prevailing systems is still available in medical terminology. Thus, it will be difficult for patients to understand, and the adverse result may cause by confusion or misinterpretation. For this reason, the health information for patients should be simplified and understandable when giving consent.

South Korea

Under the Korean HIE initiative project, there is an attempt to create a nationwide HIE network. The common HIE platform has been inspired and developed from several data standards, e.g., ICD-10, LOINC, Korea Standard Terminology of Medicine (KOSTOM), Korean Electronic Data Interchange (EDI), and Anatomical Therapeutic Chemical (ATC). Consequently, this creates supporting standard terminology, documents, and message tools for facilitating stakeholders to exchange information in the network. Such implementation guidelines will accelerate the interoperable technologies for a nationwide HIE network and mitigate technical barriers to exchanging health information (Lee et al., 2015; Feldman et al., 2014).

Philippines

In the Philippines, linking electronic medical records and health management information systems across facilities and harmonizing information between PhilHealth and the DOH is a strategic move towards a Philippine Health Information Exchange plan. At the end of the project, the government anticipates submitting all patient records to a central system that will allow healthcare providers and patients to retrieve patients' health information for medical activities. However, this remains a challenge without a national ID or a national health ID (Ng et al., 2019).

India

In India, the healthcare system encounters the limitation on data accessibility and an upshot of no infrastructure or standard being available to exchange clinical information across various providers and the different states. A national health insurance program Pradhan Mantri Rashtriya Swasthya Suraksha Mission (PMRSSM) (Lahariya, 2018), seeks to improve the accessibility, availability, and affordability of primary, secondary, and tertiary care health services. However, the referral system ineffectively performs medical service activities without semantic interoperability among healthcare providers (Pai et al., 2021). Therefore, there is a need to leverage reliable technology that will help access health information across different hospitals and various healthcare providers to encourage the active participation of stakeholders. Therefore, the National healthcare initiatives require technology solutions such as Electronic Medical Records (EMRs) and Blockchain to enable all stakeholders to set up and effectively exchange meaningful health information under a secure sharing platform and on-time response.

Based on the literature review, several articles mentioned and discussed the limitations of healthcare information sharing. However, most research does not include information categorization to HIE policy implementation or even national health information standards especially in Thailand-specific context (Van Panhuis et al.,2014; Schulz et al., 2019; Watkinson et al.,2021). Some articles stated that the investment in Thailand's Health information systems and interoperability primarily related to health information standards seems insufficient (Kawtrakul et al., 2011; Thit et al.,2016) and put an effort to mend the technical wall in order to improve health information sharing (Taechoyotin et al., 2021). However, they do not provide an assessment from stakeholders' perspectives, i.e., care providers and care receivers, to improve or form the national standard of healthcare information. Therefore, this study will help identify the conceptual standard healthcare information set for patients' referral from the perspectives of patients and healthcare professionals to ensure that the critical patients and healthcare information can be made available when needed regardless of time and distance.

Research Methodology

A mixed-methods study, namely an In-depth Interview and Quantitative Analysis, would allow for a deeper understanding of existing healthcare information systems, and requirements for healthcare information sharing in patient referral systems.

Sample Size

The population of interest in this study consists of two relevant groups, including healthcare professionals, patients, and relatives. In our selection criteria for the In-depth Interview, researchers included 20 physicians from different fields of specialties or diseases. The age range was 41 to 50, with at least ten years of working experience in patient care. In the following step, we established the quantitative research. The sample size determination for our survey was selected based on Yamane's formula for healthcare professionals and relied on Roscoe for Patients and relatives.

According to the Medical Council of Thailand data, around 29,897 physicians live in Bangkok. With this given number at a confidence interval of 95% or a P-value of 0.05, thus our sample size for the Healthcare professional would be 397 respondents as a minimum (29,897/ 1+(29,987*0.52) (Yamane, 1973). The population of patients and relative groups seems quite large, so we calculated the sample size using the infinite population method (Roscoe, 1969), based on this method with a

P-value of 0.05 and a population standard deviation equal to or not more than 10. Then 384 respondents are the minimum requirement (N = (Zcσ/em)2 = (1.96 x 10)2 = 19.62 = 384.16). Therefore, we reached 903 people as the actual number of participants in the survey, consisting of 479 people and 424 people from the Patients and Healthcare Professionals groups respectively.

Data collection

An in-depth interview was conducted with a total of 20 physicians from different fields, including Allergists, Emergency care specialists, Infectious disease specialists, Internists, Neurologists, Pediatricians, Psychiatrists, and Trauma surgeons, were involved. This interview would help to develop a guideline for the conceptual categories of healthcare information. During the conversation, we drill down their perspective on information exchange in patients' referral systems under two purpose categories; smooth patients' referral processes for patient safety and the basic set of data for better care services quality.

In the survey, we defined Healthcare professionals as physicians or nurses who may have experience giving healthcare services through the patients' referral systems, especially those involved in healthcare information sharing. Therefore, this group of people would possibly reveal their understanding, perception, and expectation for healthcare information exchange in patients' referral systems.

Meanwhile, the patients and relatives group refer to any participants between 25 and over 55 years old (Adolescence to older adults) who received healthcare services through the patients' referral systems. This group of samples can expose their experience and perception in exchanging healthcare information, affecting the diagnosis or treatment process, either for themselves or family members. Therefore, the typical exclusion criteria concerning properties of the study sample is to exclude any patients or healthcare professionals without experience in patients' referral from the current study.

Data Analysis

The objective of this paper is to explore the critical and shareable set of relevant healthcare information to the treatment process in patients' referral systems between different health service providers for the health service receivers' prosperity. Thus, the questionnaires will be distributed to healthcare professionals and Patient groups to reach consensus perspectives. Under this circumstance, the data will be split into two parts and feasibly with a structural point. For this reason, the Chow test is applied to examine whether the regression coefficients are different for split data sets or the parameters of one group of the data are equal to those of another group (Chow, 1960). For instance, the null hypothesis is $\beta 1=\beta 2$ and $\mu 1 = \mu 2$. Then, the data set can be represented in a single regression line. The null hypothesis will be rejected if the calculated F-value is greater than the F-Critical Value. The two groups' data are not poolable because of different slopes and intercepts. The Chow F Statistic formula is:

$$F = \frac{(RSS_T - (RSS_1 + RSS_2))/k}{(RSS_1 + RSS_2)/(n_1 + n_2 - 2k)}$$

Afterward, Factor Analysis is another statistical tool used to reduce or simplify a set of complex variables in the data set. By technique, the Principal Component Analysis will look at all the variables, extracts maximum variances, and put them into the typical score as the first factor. The process will be reiterated until we get to the last element, and the obtained data will be used for further statistical analysis, i.e., Linear Regression.

Research results

In the medication processes, the cost of error and delay in the transaction could result in disabilities or even loss of life. Therefore, the researchers attempted to gather the care providers' critical and necessary healthcare information in patients' referrals. During the interview, we are keen to attain the standard of healthcare information and increase its visibility. Based on this, participants were asked to reveal their perspectives on patient safety and care efficiency related to exploring better data collection and management and improving the cooperative healthcare information exchange. The ultimate goal would be finding the applicable data sets and precise movement to standard data adoption across patient referral systems. Consequently, the participants proposed the necessary healthcare information and, in some way, required surveillance and treatment. The relevant information is listed in table 1

Table 1: The information needed by healthcare professionals for caregiving through patients' referral systems (applied from Jeremy C Wyatt and J LY Liu "Basic Concept of Medical Informatics," 2002 and WHO USAID– "Rapid Assessment of Referral Care Systems," 2003. This has been adjusted after In-depth interview)

Type of information	Descriptions
Personal information	Name, gender, date of birth, nationality, height, weight, socio-economic status, address, contact details
Medical Treatment Expense	Costs to diagnose, treat, or prevent an injury or disease include health insurance premiums, including the National Healthcare Schemes in Thailand, hospital visits, and prescriptions.
Drug addiction	Behavior and Life Style, i.e., smoking and alcohol drinking
Growth	Brain and Physical Development (for children and youth patients)
Clinical Data	Administrative and demographic information, diagnosis, treatment, prescription drugs, laboratory tests, physiologic monitoring data, hospitalization, patient insurance, etc.
Drug Utilization	Drug use history and drug allergy
Principal/Specific Diagnosis	The diagnostic test result/report for a specific disorder
Diagnosis-related	Patients' classification systems categorize the costs of hospitalization and patients' hospital stay for reimbursement based on the principal diagnosis, a surgical procedure used, patient age, and expected length of stay in the hospital.
Treatment Historical report	To explain the analysis, investigations, treatments, and the effect of previous treatment.
Psychotherapy	To discover mental conditions and moods, feelings, thoughts, and behaviors related to treatment and recovery.
HIV/AIDS Infection	The scope of the HIV and AIDS Reporting Data Set is for all patients diagnosed with Human Immunodeficiency Virus (HIV) and who receive HIV care from Health Care Providers.
Monitor	Innovative medical alert systems for senior care, Subject-specific behavioral and clinical traits, or individual physiological differences.
Emergency	Injury information (data/time of injury, place type, activity, and mechanism
Symptoms/Conditions	Follow-up treatment and safeguarding concerns
Original-Recipient.Hospital location	Hospital ID, address, and Doctor ID
Referral Objectives	Episode information (including arrival and conclusion dates, source of referral, and attendance category type) Referred services and discharge information (onward referral for treatment, treatment complete, streaming)
Informant	Any person who has seen the patients at the venue, scene of accident, e.g., Primary health care workers, Rescue unit staff
Witness details	Witness for Advance Care Directives, e.g., health practitioners, care professionals
Healthcare Data usage	The use of healthcare information to benefit individuals, public health, and medical research and development. Importantly consent must be given by the data owner or patients.

In the following step, we conducted a survey consists of 903 subjects, including 424 respondents from the Healthcare Professionals group and 479 respondents from the patients' group. First, the respondents from the patient's group were asked to reveal their attitudes toward the willingness for sharing information, also the access levels to the healthcare information systems, particularly in patients' referrals the permission from patients/relatives as data owners must be acquired in any data categories in a 5-point scale to assess whether this information is permissible to reveal, without consenting or the shareability and accessibility to this information are strictly prohibited. Meanwhile, the healthcare professional responders were requested to identify the levels of healthcare information that they required to provide better and more efficient treatment in patients' referral systems; a 5-point scale was used.

From the survey, a total of 479 participants from different sectors of Bangkok, most were female 69.3%, and male 30.7%. The ages ranged from below 25 to Over 55 years. The vast majority of respondents (69.1%) were aged 55 years (28.4%), between 46-50 (14.8%), 36-40 (14.2%), 41-45 (11.7%), and 30.9% were from other age range. 36.3% of participants identified the experience in patients' referrals between divisions within the same hospital, 51.1% patients' referrals between hospitals in Bangkok, and 12.5% patients' referrals for cross-province hospitals. We discovered the participants' perspective on the current healthcare information sharing in patient's referral is mostly at Neutral 36.7 % and 32.8% for information sharing is sufficient, but accessibility may take some time. At the same time, 17.7% of respondents identified that healthcare information sharing between hospitals is limited (M = 3.38, SD =.9304).

The 424 participants in the survey were care providers, e.g., Physicians including Primary Care Physicians, Specialist Doctors, Nurses, Referralists, and some of them are executive members of medical school hospitals. Most of them were female (87%) and male (13%). The majority of respondents (63.3%) were aged between 25-30 (24.8%), 31-35 (14.2%), 41-45 (12.7%), over 55 years (11.6%) and 36.7% were from other age range. The variation in working experience starting from 11 months up to 45 years (M = 15, SD = 11.468). From the survey, 51.9% of respondents identified the experience in patient referral between divisions within the same hospital, 26.4% patients' referrals between hospitals in Bangkok, and 21.7% patients' referrals for cross-province hospitals. We discovered the participants' perspective on the current healthcare information sharing in patient referral; most of them, or 40.6%, agreed that information sharing is sufficient, but accessibility may take some time, and 24.8% are satisfied with the current cooperative healthcare information sharing. Likewise, 24.5% rated at Neutral (M = 3.79, SD =.9450).

A survey of 903 respondents related their perspectives on information shareability and accessibility. In comparison with the response of 424 subjects from the healthcare professional group, we are keen to categorize the critical and necessary data set for patient care in the referral systems. The assessment score is from 1 to 5, which is described as follows;

1. implied that the shareability and accessibility of this information is prohibited
2. implied that the shareability and accessibility of this information are permissible only for the critical and treatment-related person.
3. implied that the shareability and accessibility of this information are permissible but considerably on a case basis.
4. implied that the shareability and accessibility of this information are permissible; consent is required in any transaction.
5. implied that the shareability and accessibility of this information are permissible without consenting in any transaction.

After that, the descriptive statistic result for each information category could be illustrated as below;

Table 2: Comparison of Means between two groups of respondents (Patients and Healthcare Professionals) in each information category (X1-X19)

Data categories	Comparison of Means	
	Patients	HCP
Personal information (X1)	3.772	4.505
Medical treatment expense (X2)	3.831	4.639
Drug Addiction (X3)	3.453	4.399
Growth (X4)	3.835	4.448
Clinical Data (X5)	3.699	4.790
Drug Utilization(X6)	3.825	4.833
The principal or Specific diagnosis (X7)	3.520	4.743
Diagnosis-related (X8)	3.566	4.675
Treatment Historical report (X9)	3.841	4.634
Psychotherapy (X10)	2.704	4.271
HIV/AIDS Infection (X11)	2.551	4.604
Monitor (X12)	3.643	4.795
Emergency (X13)	3.967	4.613
Symptoms/Conditions (X14)	4.008	4.823
Original-Recipient Hospital details (X15)	3.927	4.554
Referral Objectives (X16)	4.109	4.550
Informant (X17)	4.075	4.665

Data categories	Comparison of Means	
	Patients	HCP
Witness details (X18)	3.825	4.111
Data usage (X19)	3.347	4.302

Interestingly, the healthcare professional group's mean score (table 2) seems higher than the patients' group in several information categories. After eliciting the response from both groups' subjects, we aim to examine the Chow F statistic test to prove whether the two groups have different perspectives towards the shareability and accessibility of each information category. The statistic result is F (20, 863) =1.89, Prob > F = 0.0107, which mean the null hypothesis is rejected. The coefficients in the two different datasets are inequal and differ by showing in two different single regression lines. For instance, some information categories, i.e., drug addiction, HIV infection, or mental conditions, may be seen as crucial data for care providers. However, the care receivers would like to limit or prohibit its accessibility. This mindset will conclusively affect the quality of treatment or healthcare services, and this limited health literacy may pose a risk to patient safety.

A patient's understanding of health information would be an integral part of the transformative healthcare environment. Predominantly, the mutual understanding between patients and their doctors is significantly crucial. Irrefutably, there is a discrepancy between individual perceptions due to distinct health literacy, mainly when health information and records appear in medical terminology. In this study, we presume that medical terminology would be one of the difficulties for the patients to take in and understand. Sometimes, the misunderstood or wrong interpretation caused by numerous details and sources can also occur on both sides of care providers and care receivers. In practice, with informed consent, the patients need to understand the purpose of medical treatment, and they agree to receive it before the treatment begins. Therefore, our survey questions are based on the commonly used health information identified by the healthcare professionals during the in-depth interview. We then summarized it in 19 variables for reconfirming with patients before running the statistical test.

Factor Analysis was applied in the following step to reduce many variables into fewer numbers factors. This variable reduction technique would help simplify and develop a shared understanding of involved parties. The Kaiser-Meyer-Olkin (KMO) test result is at 0.935, which indicates that the sum of partial correlations is not large relative to the sum of correlations. Thus, Factor Analysis should yield distinct and reliable factors for this data set.

Factor analysis/correlation Number of Obs = 903
Method: Principal-component factors Retained factors = 3
Rotation: Unrotated Number of params = 54

Table 3: Factor Analysis

Factor	Eigenvalue	Difference	Proportion	Cumulative
Factor1	9.50814	7.72687	0.5004	0.5004
Factor2	1.78127	0.67347	0.0938	0.5942
Factor3	1.10780	0.18301	0.0583	0.6525
Factor4	0.92479	0.16017	0.0487	0.7012
Factor5	0.76462	0.16074	0.0402	0.7414
Factor6	0.60388	0.06069	0.0318	0.7732
Factor7	0.54319	0.00253	0.0286	0.8018
Factor8	0.54066	0.09433	0.0285	0.8302
Factor9	0.44633	0.01520	0.0235	0.8537
Factor10	0.43112	0.06630	0.0227	0.8764
Factor11	0.36483	0.00852	0.0192	0.8956
Factor12	0.35631	0.02408	0.0188	0.9144
Factor13	0.33223	0.03836	0.0175	0.9319
Factor14	0.29386	0.04241	0.0155	0.9473
Factor15	0.25146	0.01761	0.0132	0.9606
Factor16	0.23384	0.02830	0.0123	0.9729
Factor17	0.20554	0.01101	0.0108	0.9837
Factor18	0.19454	0.07895	0.0102	0.9939
Factor19	0.11558	.	0.0061	1.0000

Table 4: Factor loadings (Pattern Matrix) and unique variances

Variable	Factor1	Factor 2	Factor 3	Uniqueness
X1	0.5289	-0.1909	0.4337	0.4957
X2	0.6152	-0.1672	0.2391	0.5364
X3	0.6594	-0.3216	0.2724	0.3876
X4	0.6492	-0.1358	0.4151	0.3878
X5	0.7501	-0.3293	0.0865	0.3215
X6	0.7559	-0.3105	0.0445	0.3303
X7	0.8187	-0.2836	-0.1983	0.2100
X8	0.8203	-0.2813	-0.2214	0.1990
X9	0.7528	-0.0281	-0.0086	0.4324
X10	0.7818	-0.1208	-0.0778	0.3682
X11	0.7201	-0.2296	-0.1405	0.4090
X12	0.7691	0.0425	-0.3931	0.2522
X13	0.6819	0.0870	-0.3829	0.3808
X14	0.7571	0.2178	-0.2815	0.3002
X15	0.7087	0.4485	0.0104	0.2965
X16	0.6963	0.5295	0.0727	0.2295
X17	0.6611	0.4922	0.0521	0.3180
X18	0.5491	0.5823	0.2610	0.2913
X19	0.6818	0.2069	0.1894	0.4565

Table 3 contains the initial number of factors and the eigenvalues (variance of the factors). According to the default mineigen (0) criterion, a factor should have an eigenvalue greater than zero to be retained, in this case, 19. However, this study kept only the first three factors after the extraction by determining the correlation matrix in table 4. Although the factor elected to retain three factors, only the first factor appears meaningful. The first factor describes the respondents' average attitude towards the critical and shareable items. Some variables present the reversed responses, or the loadings are negative, which means the respondents may feel that the identified data should not majorly influence the treatment process. At the same time, this data encountered any objection or restriction for information sharing. As a result, the patients will likely disagree with these items and agree with other items. The Uniqueness column confirms no communality.

Factor analysis/correlation	Number of Obs = 903
Method: Principal-component factors	Retained factors = 3
Rotation: orthogonal varimax (Kaiser off)	Number of params = 54

Table 5: Factor Analysis (Rotated)

Factor	Variance	Difference	Proportion	Cumulative
Factor1	5.14828	1.23799	0.2710	0.2710
Factor2	3.91029	0.57164	0.2058	0.4768
Factor3	3.33865	.	0.1757	0.6525

Table 6: Factor loadings (Pattern Matrix) and unique variances (Rotated)

Variable	Factor1	Factor 2	Factor 3	Uniqueness
X1	0.1325	0.1991	0.6687	0.4957
X2	0.3140	0.2291	0.5590	0.5364
X3	0.3676	0.1303	0.6784	0.3876
X4	0.2115	0.3049	0.6888	0.3878
X5	0.5556	0.1380	0.5922	0.3215
X6	0.5820	0.1491	0.5557	0.3303
X7	0.7784	0.1607	0.3979	0.2100
X8	0.7941	0.1593	0.3809	0.1990
X9	0.5323	0.3724	0.3816	0.4324
X10	0.6253	0.2981	0.3897	0.3682
X11	0.6563	0.1639	0.3652	0.4090
X12	0.7778	0.3699	0.0770	0.2522
X13	0.6980	0.3628	0.0199	0.3808
X14	0.6441	0.5293	0.0689	0.3002
X15	0.3497	0.7481	0.1473	0.2965
X16	0.2760	0.8200	0.1479	0.2295
X17	0.2764	0.7667	0.1331	0.3180
X18	0.0343	0.8202	0.1864	0.2913
X19	0.2832	0.5657	0.3786	0.4565

From table 5, applying the orthogonal rotation (Varimax) method minimizes the number of variables with high loadings on each factor. This solution would also represent the correlation between the variables and the factor. The uniqueness value or proportion of the common variance of the variable not associated with the factors could confirm no communality after rotation. In describing the respondents' mutual agree by considering rotated factor loadings and unique variances, the variables in each factor could be sorted as follows;

1.) 9 number of items in Factor 1, which is composed of X8 X7 X12 X13 X11 X14 X10 X6 X9 (Scale reliability coefficient: 0.9237)

2.) 5 number of items in Factor 2, included X18 X16 X17 X15 X19

(Scale reliability coefficient: 0.8720)

3.) 5 number of items in Factor 3 consist of X4 X3 X1 X5 X2

(Scale reliability coefficient: 0.8169)

Table 7: Factor rotation matrix

	Factor 1	Factor 2	Factor 3
Factor 1	0.6885	0.5276	0.4975
Factor 2	-0.2931	0.8300	-0.4745
Factor 3	-0.6633	0.1809	0.7261

Source	SS	Df	MS	Number of Obs = 903
				F (3, 899) = 15.11
Model	39.7462407	3	13.2487469	Prob > F = 0.0000
Residual	788.499606	899	.877085213	R-squared = 0.0480
				Adj R-squared = 0.0448
Total	828.245847	902	.918232647	Root MSE = .93653

Table 8: Regression after Factor Analysis

Y	**Coef.**	**Std. Err.**	**t**	**P>ltl**	**[95% Conf. Interval]**	
Expert Based	.131258	.031183	4.21	0.000	.070058	.1924579
Admin	.0269272	.031183	0.86	0.388	-.0342727	.0881271
Patient Specific	.1615885	.031183	5.18	0.000	.1003886	.2227884
_Cons	3.578073	.0311657	114.81	0.000	3.516907	3.639239

After renaming composition, the above-given factors are Expert-based, Admin, and Patient-specific, respectively. Then, regression analysis subsequently examines the relationship between each element as the independent variable and the willingness of information sharing as a dependent variable. Table 8 statistically revealed that the information categories, including Patient-specific (P-value = 0.000), consist of Personal information (X1), Medical treatment expense (X2), Drug Addiction (X3), Growth (X4), and Clinical Data (X5). Expert-based (P-value = 0.000) is composed of Drug Utilization (X6), The principal or Specific diagnosis (X7), Diagnosis-related (X8), Treatment Historical report (X9), Psychotherapy (X10), HIV/AIDS Infection (X11), Monitor (X12), Emergency (X13), and Symptoms/Conditions (X14). These factors could limit or benefit the information-sharing decision from both groups of respondents. Correspondingly, these data categories should schematize as vulnerable or confidential information. As a consequence of data breaches, it would be harmful in terms of patients' identification, which some data may eventually impact each aspect of lives. In addition, the quality of treatment could follow the individual difference in health literacy. This communication error does not happen between healthcare professionals and their patients but could lead to misinterpretation during patient referral and a terrible blunder in caregiving. In contrast, administrative data seems visibly disclosure information with unrestricted accessibility.

Since the conceptual categories of healthcare information is earnestly used to interconnect among stakeholders in the healthcare supply chain, including hospitals or between physicians and patients, both sets of questionnaires included an open-ended question that allowed the respondents to provide their comments, ideas, and suggestions through their experiences. Some difficulties are often an essential and unavoidable part of a patient's referral, e.g., the additional cost and time-consuming during patient transfer services. Considering the benefits of digitizing patient referrals process should be simple, secure, and seamless. For instance, generating a single standard platform that will increase data visibility and accessibility by reducing waiting time could lead to modest health outcomes and decrease the burden of family care. Undeniably, adopting electronic health records with meaningful use can improve the quality of care, treatment, and medication. Indeed, accurate coding and recording will enhance patient safety, especially for emergency cases with any unconscious patients or without family presence. Nevertheless, the consistent and comprehensive recording of drug allergies seems not often available in electronic health records. This poor historical record sometimes induces "Anaphylaxis," a severe adverse drug reaction in some patients, resulting in death. Especially in the current situation of the COVID-19 pandemic, there is a huge demand for public health resources and services. For instance, Healthcare professionals, facilities, and health information exchange, e.g., Lab results or X-ray results to be developed for higher accuracy and time convenience are needed. However, the respondents worried the cyber security because some confidential health information could be commercially distributed unintentionally and vice versa. Though using Blockchain may help ease the information exchange in securely transfer encrypt patient data, the comprehensive healthcare information exchange system includes Policy setting and enforcement, the entire development of Hardware, Software, and Peopleware (for Skills & Mindset) remains tremendous importance as a ground to the sustainable development of National Public Health system. Likewise, data security should be applied, i.e., Personal Data Protection Policy. In practice, a data integration system should provide consistent access and delivery of data across the area and sources to meet the information needs of all Clinical applications and treatment processes for patient safety and wellness outcomes.

Discussion

The objective of our study is the standard healthcare information for patient safety and care efficiency in time and cost; hence, it is vital to construct the data analysis of the attitudes toward shareability and accessibility for healthcare information categories. Importantly, this is similar to other industries' manner the voice of customers, which in this study referred to both patients and healthcare professionals, could improve services quality and enhance users' experiences. As a result, the healthcare professionals characterized the healthcare information into 19 information categories, including Personal Information, Medical Treatment Expense, Drug addiction, Growth, Clinical Data, Drug Utilization, Principal/Specific Diagnosis, Diagnosis-related, Treatment Historical report, Psychotherapy, HIV/AIDS Infection, Monitor, Emergency, Symptoms/Conditions, Original-Recipient Hospital details, Referral Objectives, Informant, Witness details and Data usage.

The previous studies noted the positive effect of information sharing on the efficiency of the supply chain. In addition, the advancement of information technology in recent years has empowered healthcare organizations to improve their service flow and the information flow via efficient mechanisms. For instance, information technology and data visibility will increase patients' accessibility to safe, quality, and appropriate health services and treatment. Therefore, similar to other industries, well-organized information sharing will enhance supply chain performance. In addition, it will prevent redundant transactions and unnecessary costs and allow enterprises to refine their supply chain management strategies to evolve the service quality and maximize patient benefits. This study draws a possible implementation approach and practice for healthcare information sharing from the previous section. Beyond being the supportive technology for enhancing secure interconnectivity and a secure information-sharing platform of healthcare data, Blockchain is seen as innovative information management that delivers health-related data when needed to support decision-making in the care process. Even though stakeholders might run into the emerging conditions, this will remain state of the art about cyber security. In Blockchain, the transactions are created and exchanged within the blockchain network, and the data structure should be modified (Spanakis et al.,2021). We then proposed the construction of healthcare information sharing as follows;

1) Patient-specific – This section should allow patients to enter and edit their information. In addition, they should be able to control the data accessibility and visibility, e.g., some data may be open for public searches without authorization. Likewise, the patients can provide their consent and

revoke their permission or approval for some data at any request. Furthermore, using one time using password or token should be applied for the person's verification and prevent information leaks at a practical level.

2) Expert-based – Access to this information should require authorization and authentication, i.e., limit use to licensed healthcare professionals, specifically, single governing systems that control the national data repository, which should enhance or facilitate efficient information integration and sharing along with strengthening collaboration among hospitals. However, having figured out the complicated current situation, developing a single data pool for this type of information is very challenging due to difficulties in synchronizing and centralizing from discrete healthcare information sources. Thus, the overriding mandatory rules and related public policies, e.g., enforcing standard code and a single platform for patient referral. In the meantime, as the comprehensive action plan in healthcare, the improvement of patients' health literacy is, consequently, a priority and should be conducted in parallel, i.e., digital health reports, manuals, or guidelines for patients.

3) Administrative data: This data category should be available in the healthcare system to enable traceability and improve care continuity. The information needs to be accurate, consistent, and regularly updated by the care providers. Notably, the patients and relatives should be notified and request additions or corrections.

As aforementioned, in the research findings, we classified health information into three categories, i.e., Patient-specific, Expert-based, and Administrative data. In the management aspect, each data category implies four types of data: public, internal-only, confidential, and restricted. For instance, some data in the Patient-specific group, e.g., names of patients and relatives, can be freely accessible to the public, allowing the healthcare providers to reuse and redistribute without repercussions. Nonetheless, this requires mutual agreement for information disclosure on whether such data could turn into internal only or confidential data when the patients demand. In comparison, the restricted data may not allow the third party to be compromised or accessed without authorization due to the possible high risk of criminal charges and massive legal fines or cause irreparable damage to the patients, healthcare professionals, and organizations. This health information classification would assist healthcare organizations in easing data accessibility and retrieval to increase data integrity while maintaining confidentiality. Moreover, it reduces the danger of unstructured sensitive information becoming vulnerable to cyberpunks and saves health organizations from steep data management and storage costs.

Furthermore, this research findings would benefit as a primary step to overcome the obstacles of the lack of a national standard that some previous studies mentioned. It also contributes to the nationwide standard health information development process by simplifying the data categories instead of using specific terminology, i.e., ICD10 and LOINC, to enable understanding in patients with low to moderate health literacy. However, multi-authority access control needs to be considered in the patients' referral system and involves blockchain technology applications (Triantafyllou et al.,2020). Therefore, we recommended that these three items be categorized as the Private and Permissioned Blockchain rather than Public and Permissioned less Blockchain because some transactions may be relevant to any vulnerable health information. Furthermore, to achieve a nationwide adoption of patient-centric HIE, it is vital to understand the distinction between patients' health literacy, attitude, and influencing factors towards their willingness to share and engage in the healthcare process. Therefore, launching a comprehensive campaign to raise awareness and alleviate patients' perception of accountability and the exactness of privacy policies is a more helpful approach.

Knowledge from Research

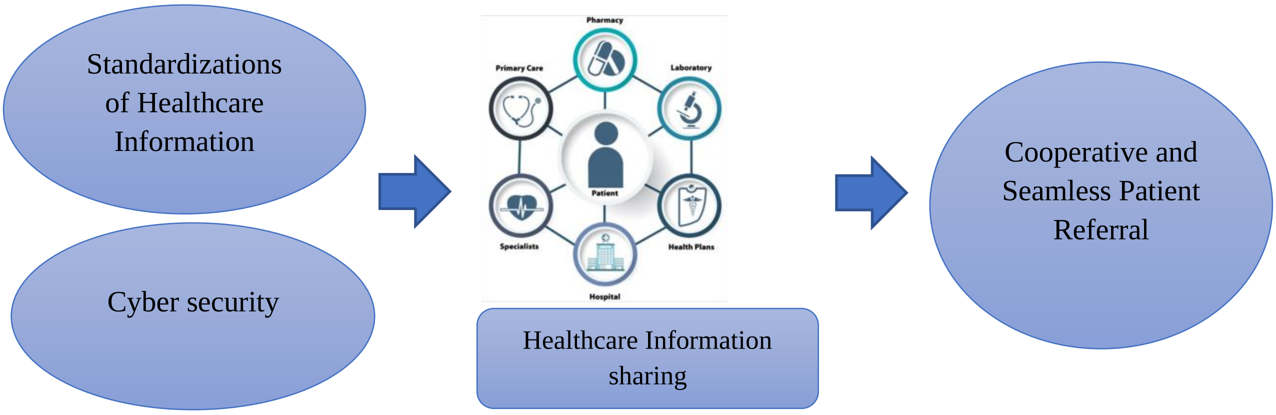

Fig.1 The knowledge from research

The health information categorization will support health information sharing between patients and their healthcare providers to help improve diagnoses and therapy effectiveness. Given Public health policy implications, the proposed healthcare information categories will enhance interoperability among care providers to improve care quality and health prosperity of patients through consistent and comprehensive recording. Besides, the data integration system should provide consistent access and delivery of data across the area and sources to meet the information needs of all Clinical applications and treatment processes for patient safety and wellness outcomes. Moreover, accurate coding and recording will improve patient safety, especially for emergency cases with unconscious patients or without family presence. Notably, the standardization of healthcare information with cyber security should substantially enhance healthcare information sharing between healthcare organizations, care providers, and patients. Ultimately, this will improve the quality of healthcare services and become the national cooperative and seamless patient referral practice.

Conclusions and Recommendations

Thailand is a leading medical tourism hub and plans to transform into Asia-Pacific Medical Hub; however, the initiative policy management and strategic movement remain a current and forthcoming challenge in Thailand's health system development. Thenceforward, in this study the researchers categorized the 19 information categories into three data groups: patient-specific, expert-based, and administrative data. Moreover, the broader use of the patient-centered approach will enable and increase interoperability among healthcare organizations. Hence, the significant benefit of the paper is in generating the management platform that possibly is a constitutional concept to respond to the need for national healthcare data standards and lead to the standardization of healthcare information for patients’ referral process. The personalized feedback from care providers and care receivers to identify the specific ways they could offer alternatives for improvement and development in the healthcare system and the driving force of the influential regulators or the decisive direction from the public health policymakers are imperative components.

Meanwhile, advocacy on the potential benefits of using data standards and communication between the organizations and the users greatly benefits from controlling or manipulating the possible conflict and misunderstanding. Above and beyond, the standards maintenance and revision processes are part of the compulsory components of successful implementation and the acquiring resources and personnel in the specific related field. Furthermore, cultivation, incentives, service mindset, and capacity building are essential.

Nonetheless, prosperous and sustainable healthcare information systems require the central body to earnestly consider the distinct level of health information literacy and competencies. Therefore, further research on the distinctive health information literacy on an individual level will help address and contribute to developing health information literacy and competencies in Thai citizens.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research(s), authorship, and/or publication of this article.

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