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Barriers to Electronic Health Record System Implementation and Information Systems Resources: A Structured Review

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Abstract

Electronic health record systems have the potential to improve the quality of health services primarily through the availability of health information. Implementing EHR systems in healthcare facilities has been met with an alarming rate of failure. This paper reviews the literature identifying barriers to implement an EHR system. Identifying the barriers will be a precursor to assessing readiness for such a system. A structured literature review was done in accord with the PRISMA guidelines. The barriers identified were categorized into the information systems resources. The review suggests that people resource (user resistance and lack of skills) and procedure resource (concern for return on investment and lack of administrative and policy support) are the primary barriers to overcome. Further studies are directed to examine the barriers in detail and recognize how to address said barriers.

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Keywords: electronic health record; information system resource; barriers

1. Introduction

An electronic health record, or EHR, is defined as “a longitudinal health record and includes all information contained in a health record such as a patient’s health profile, behavioral and environmental information” [1]. This information includes data obtained from multiple episodes and providers, with the intention of being a lifetime medical record. The EHR contains all the personal health information belonging to an individual, is entered electronically by healthcare providers over the person’s lifetime, and extends beyond inpatient care to ambulatory

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care settings [2].

Numerous healthcare facilities from across the globe have implemented EHR systems to improve the information recording process but only a few have been successful [3]. The percentages of failures are alarmingly higher in adoption and meeting the desired benefits from the implementation. More than 50% of EHR systems either fail or fail to be properly utilized [4][5][6]. Resistance and opposition in changing from the paper-based systems to electronic systems may create some problems [2]. Some other issues contributing to the stats include the lack of pre-implementation activities [4], lack of organizational readiness [7][8][9], unavailability of technology, funding and lack of technical and computer skills of personnel [10].

Readiness assessment can help healthcare facilities identify barriers to a successful EHR system implementation and measure the preparedness of the organization as well as its available resources and areas to improve. Ghazisaeidi et al. [11] recognized readiness assessment as the most important step prior to implementation and an essential requirement for the success of EHR in terms of adoption rate or acceptance. Readiness assessment, as a comprehensive measure in order to provide a proper image of existing conditions and the preparedness of healthcare organization to change, is also a way to identify potential cause of failure in innovation such as organizational resistance. Khoja et al. [8] emphasized that readiness assessment becomes important because of potential resistance to the implementation of EHR. Readiness assessment evaluates the preparedness of an organization and it leads to improved decision making and planning strategies.

An electronic health record system has the potential to improve the overall quality of health services including the availability and reliability of health information. Identifying the barriers will be a precursor to assessing readiness to adopt an EHR system. This paper reviews the literature identifying barriers to implement an EHR system.

2. Methods

A structured literature review was done to identify the barriers that relate to EHR readiness. The said review was done in accord with Preferred Reporting Items for Systematic Reviews and Meta-Analysis, or PRISMA guidelines for systematic review and meta-analyses.

2.1. Search strategy

Articles for this review were gathered from the electronic database ProQuest. The search strategy included four categories of keywords: (i) “readiness” OR “readiness assessment”; (ii) “electronic health” OR “e-health”; (iii) “electronic health record” OR “electronic medical record”; and (iv) “readiness” OR “readiness assessment” AND “electronic health” OR “e-health”.

2.2. Study selection process and data extraction

An article was included if it satisfied the inclusion criteria: (1) publication (the article was published in a scholarly journal no later than July 2016); (2) language (the article was written in the English); (3) status (the article’s full text is available); and (4) content (the article listed barriers to the implementation or adoption of EHR or EMR). An article was excluded if it presented a meta-analysis of barriers.

All titles and abstracts were screened for potentially eligible studies. Initially two reviewers screened all titles and abstracts for potentially eligible studies. Studies that did not meet the criteria were deleted from the list. Disagreements were resolved through group discussion. All reviewers then evaluated the full text of each study independently to make the final selection of relevant articles to include. Studies were reviewed by the researchers to ensure they complied with the inclusion and exclusion criteria. The selected data sources were collated and summarized using a spreadsheet application.

The researchers identified barriers from each of the studies that met the inclusion criteria. A list was organized using a shared spreadsheet. The identified barriers which were regarded similar in nature, during the group discussion, were merged. A researcher was assigned to initially categorize the barriers based on the definition of the information systems resource. After completing the process, the rest of the researchers underwent iterations to categorize the barriers. The components of information systems as specified in O’Brien et al. [12] - people resources,

hardware resources, software resources, data resources and network resources - were used as the categories for classifying the barriers. Procedure, from [13][14], was added as a component of an information system.

Table 1. Information systems resource and definition

Information systems resource	Definition
People [12]	People resources include end users and information systems specialists. End users use an information system or the information it produces. They can be customers, salespersons, engineers, clerks, accountants or managers that are found at all levels of an organization. IS specialists develop or operate information systems. They include system analysts, software developers, system operators and other managerial, technical and clerical IS personnel.
Hardware [12]	Hardware resources include physical devices or materials used in information processing. Specifically, it includes not only machines, such as computers and other equipment, but also all data media, that is tangible objects on which data are recorded, from sheets of paper to magnetic or optical disks.
Software [12]	Software resources include all sets of information processing instructions. It includes not only the sets of operating of operating instructions called programs, which direct and control computer hardware, but also the sets of information processing instructions called procedures that people need. Software resources are important to capture, process and disseminate information to their users.
Data [12]	Data can take many forms, including traditional alphanumeric data, composed of numbers, letters and other characters that describe business transactions; text data, image data, and audio data.
Network [12]	Network resources, as a concept, emphasize that communications technologies and networks are fundamental resource components of all information systems. It includes communication media such as twisted-pair wire, coaxial and fiber optic cables, and microwave, cellular, and satellite wireless technologies. Network infrastructures include modems and internetwork processors, and communication control software, such as network operating systems and Internet browser packages.
Procedure [13][14]	Procedures include the strategies, policies, methods, and rules for using the computer based information system, including the operation, maintenance, and security of the computer; A frequently overlooked component of information systems

3. Search results and identification of barriers

Figure 1 illustrates the search process used and the corresponding results. A total of 5,626 primary articles were identified for initial screening. Subsequently, 757 articles were removed after being tagged as duplicates. After controlling for duplicates, the titles and abstract of 4,869 articles were screened. In this process, the researchers read all the abstracts and noted all the relevant articles. After the screening for abstract review, 175 articles were retained for full-text review. A total of 137 articles were excluded based on the full text review. No additional relevant articles were found within the reference lists. A total of 38 articles met the inclusion criteria (Table 2). The 38 articles that met the inclusion criteria yielded 57 barriers to the implementation of EHR systems.

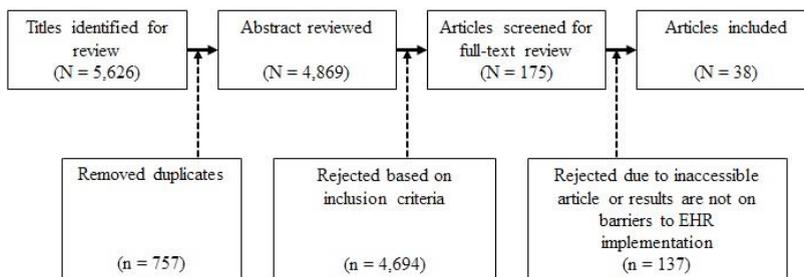


Fig. 1. Flowchart and result of review process

Table 2. List of 38 articles included in this study

Ref	Author	Ref	Author
[6]	Miller et al.	[32]	Nasiripour et al.
[11]	Ghazisaeidi et al.	[33]	Nguyen et al.
[15]	Gagnon et al.	[34]	Shank et al.
[16]	Shah et al.	[35]	Wang et al.
[17]	Asadi et al.	[36]	Campion et al.
[18]	Habibi-Koolaei et al.	[37]	Cherry
[19]	Kruse et al.	[38]	Castillo et al.
[20]	Ross et al.	[39]	Jha
[21]	Standing et al.	[40]	Bowens et al.
[22]	Tuot et al.	[41]	Nakamura et al.
[23]	Adebayo et al.	[42]	Schneider
[24]	Ayatollahi et al.	[43]	Torda et al.
[25]	Goldstein et al.	[44]	Jha et al.
[26]	Heisey-Grove et al.	[45]	DesRoches et al.
[27]	Noureldin et al.	[46]	Pourasghar et al.
[28]	Shea et al.	[47]	Williams et al.
[29]	Ajami and Arab-Chadegani	[48]	Hillestad et al.
[30]	Ajami and Bagheri-Tadi	[49]	Davidson et al.
[31]	Mair et al.	[50]	Bates et al.

4. Barriers to EHR Systems and Information Systems Resources

The analyzed papers highlighted different barriers which were then categorized into each of the information system resources. Table 3 provides an aggregate view of the number of articles that tackled an issue relating to the corresponding resource.

Table 3. Count of articles with issues for information systems resource

Information system resource	Number of articles out of 38 (%)
People resource	36 (94.73%)
Hardware resource	16 (42.10%)
Software resource	25 (65.78%)
Network resource	4 (10.52%)
Data resource	20 (52.63%)
Procedure resource	31 (81.57%)

Tables 4 to 9 identified and categorized the barriers for each of the information systems resource. Based on the consolidated list of barriers, barriers relating to procedure resource had the most number while hardware and network resources had the least.

4.1. People Resource

The review results recognized user resistance, the lack of education and training, and the lack of awareness of EHR/EMR and its importance as the primary barriers to the implementation of electronic health record systems. Gagnon et al. [15] highlights addressing physician's perceptions on the ease of use and perceived usefulness of the EHR system as well as professional and social norms, personal identity and computer-self efficacy. Kruse et al. [19] noted misunderstanding of administrative and clinical users on the benefits of the EHR system will hinder its effective implementation. The challenge of transitioning to a new system which can be associated with fear of change can contribute to the rejection of the EHR system. The engagement of developers as well as other stakeholders able to influence the implementation of the EHR system as a project have to be ensured and monitored [21]. The competency of stakeholders on ICT to gain appreciation of the utility as well as the value of the EHR system has to be addressed.

Table 4. Barriers associated with people resource

Barriers	Reference numbers	Count
1 User resistance	[6, 15, 19, 21, 24, 28, 30, 37, 40, 41, 44-47, 50]	15
2 Lack of computer skills	[23, 25, 28-30, 32, 42]	7
3 Increase of nurses and physician's workload	[6, 18, 19, 21, 24, 27, 28, 30, 36, 45, 46]	11
4 Lack of technical expertise	[25, 29, 30, 35, 37, 42, 43]	7
5 Lack of education and training	[15, 18-20, 23, 25, 26, 30, 31, 35, 36, 40, 43, 47, 48]	15
6 Inadequate staff	[16, 17, 19]	3
7 Provider or patients age	[19]	1
8 Lack of awareness of EHR/EMR and its importance	[15, 19, 20, 22, 24, 26, 29, 32, 35, 38, 40, 46, 49]	13
9 Reduces productivity and disturbs workflow	[11, 28, 29, 38]	4
10 Affects physician-patient interaction	[28, 30, 34]	3
11 Lack of healthcare providers' involvement in the design and implementation of EHRs	[21, 24, 26]	3
12 Change in culture required to embrace technology	[19, 32, 37]	3
13 Illiteracy on the part of patients	[23]	1
14 Communication among users on data entry	[30, 38]	2
15 Physicians' experience with poor products	[43]	1
16 User access limitation	[17]	1

4.2. Hardware, Software and Network Resource

The lack of IT facilities and equipment was commonly tagged in the literature as a hurdle in implementing EHR systems. The technical or IT infrastructure for the EHR system to operate effectively should be available [11][35]. Interoperability of the software was also seen as a detriment. Software meeting the needs of the organization and demonstrating ease of use are recognized as challenges. Software developed without understanding stakeholders' demands will negate confidence to or hamper the implementation of the EHR system [25]. Nasiripour et al. [32] acknowledges the need for the provision of adequate telecommunications coverage as well as access to proper internet speed as obstacles to, more broadly, the country's e-health development.

Table 5. Barriers associated with hardware resource

Barriers	Reference numbers	Count
1 Lack of IT facilities and equipment	[6, 11, 15, 17, 19, 23-25, 30, 35, 36, 46, 47]	13
2 Concern that system will become obsolete	[45]	1
3 Hardware functionality issues	[19, 26, 29]	3

Table 6. Barriers associated with software resource

Barriers	Reference numbers	Count
1 Lack of interoperability	[6, 11, 17, 19, 20, 24, 29, 30, 34, 38, 41, 42, 44]	13
2 Ease of use	[19, 25, 27, 29-31, 49]	7
3 Lack of appropriate infrastructure for integration of EHR with other existing information system	[15, 21, 22, 24, 49]	5
4 Lack of system maintenance	[19, 23, 38]	3
5 Software that meets organization's needs	[19, 24, 28, 35, 41, 44, 46]	7
6 The EHRs applications (functionalities) are not standardized	[29, 36]	2
7 System configuration issues	[19]	1

Table 7. Barriers associated with network resource

Barriers	Reference numbers	Count
1 Lack of internet connectivity	[24, 25]	2
2 Lack of network communication infrastructure	[17]	1
3 Network speed	[30]	1

4.3. Data Resource

The review regarded concerns arising from the privacy and confidentiality of data as a deterrent in EHR system implementation. Risks associated with the breach of sensitive data have to be managed. Nasiripour et al. [32] highlights concerns on ensuring the patient's privacy and further puts forward data standards adopted in the context of several countries.

Table 8. Barriers associated with data resource

Barriers	Reference numbers	Count
1 Lack of health information data standards	[29]	1
2 Data Security	[19, 30, 33, 34, 45]	5
3 Data accuracy	[32, 42]	2
4 Data quality	[23, 32, 34]	3
5 Lack of capacity to use real-time data	[16, 23]	2
6 Concerns about privacy and confidentiality	[17, 18, 20, 29-32, 34, 40, 42, 43-45, 48, 50]	15
7 Lack of centralized healthcare database	[23]	1
8 Health terminology and classification	[17, 24, 29, 48]	4
9 Lack of a national health information network	[24]	1

4.4. Procedure Resource

The literature indicated return on investment as well as the lack of administrative and policy support as concerns that might inhibit the implementation of EHR systems. Costs associated with acquiring the needed infrastructures and skills as well as concern on the return on investment have been highlighted in the reviewed papers. The successful implementation of such as system will require the support and commitment of the executives to quality improvement [22]. Integrating EHR systems into healthcare facilities have to hurdle incorporating it into the facility's current workflow [40] which will likely be met with resistance.

Table 9. Barriers associated with procedure resource

Barriers	Reference numbers	Count
1 Lack of project planning	[11, 19, 21, 35, 36, 39, 43]	7
2 Cost of equipment purchase	[18, 19, 29, 41, 47-49]	7
3 Implementation costs	[11, 19, 26, 29, 30, 37, 42, 47, 48]	9
4 Maintenance cost	[15, 37, 41, 44, 47]	5
5 Initial cost	[6, 15, 23, 29, 35, 40, 44, 45, 50]	9
6 Lack of available funding	[11, 20, 23, 29, 31, 36, 40, 48]	8
7 Training cost	[32, 47]	2
8 Concern about the return on investment	[15, 22, 23, 29, 37, 40, 43-45, 48]	10
9 Lack of capacity to select, contract for, and implement an EHR	[11, 30, 35, 39, 44, 45]	6
10 Implementation issues	[19, 26, 43, 44]	4
11 Lack of administrative and policy support	[6, 11, 15, 19-21, 36, 38, 46, 47]	10
12 Concern about physicians' legal liability	[22, 45]	2
13 Unrealistic expectation about ease of installation	[43]	1
14 Competitiveness among healthcare institution	[19]	1
15 Risk of new regulatory requirements	[35]	1
16 Waiting to see if subsidies develop	[16, 29, 49]	3
17 External factors that can impact the ability to achieve its strategic goals and objectives	[19]	1
18 Lack of future support from vendors for upgrading and maintaining the system	[26, 29, 30, 42, 44, 49, 50]	7
19 The number of vendors in the marketplace	[11, 26, 29]	3

5. Conclusion

This paper reviewed the literature identifying barriers to implementing an EHR system with reference to information systems resources. The review provides insights on how barriers to implementing EHR systems relate to information systems resources. User resistance, lack of education and training, and concerns arising from data security were the predominant barriers recognized from the analyzed papers. Further studies are directed to examine the barriers in detail and recognize how healthcare facilities address them. Other databases such as PubMed, Science Direct and Springer Link can also be utilized to obtain additional list of articles to consider for review.

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