



[BMC Health Serv Res](#). 2014; 14: 370.

PMCID: PMC4162964

Published online 2014 Sep 4. doi: [\[10.1186/1472-6963-14-370\]](https://doi.org/10.1186/1472-6963-14-370)

PMID: [25190184](https://pubmed.ncbi.nlm.nih.gov/25190184/)

# Implementing electronic health records in hospitals: a systematic literature review

[Albert Boonstra](#), [Arie Versluis](#), and [Janita F J Vos](#)

Faculty of Economics and Business, University of Groningen, Groningen, The Netherlands

Deloitte Consulting, Amsterdam, The Netherlands

Albert Boonstra, Email: [albert.boonstra@rug.nl](mailto:albert.boonstra@rug.nl).

[Contributor Information](#).

✉Corresponding author.

Received 2013 Sep 23; Accepted 2014 Aug 11.

[Copyright](#) © Boonstra et al.; licensee BioMed Central Ltd. 2014

This article is published under license to BioMed Central Ltd. This is an Open Access article distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/2.0>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly credited. The Creative Commons Public Domain Dedication waiver (<http://creativecommons.org/publicdomain/zero/1.0/>) applies to the data made available in this article, unless otherwise stated.

## Abstract

### Background

The literature on implementing Electronic Health Records (EHR) in hospitals is very diverse. The objective of this study is to create an overview of the existing literature on EHR implementation in hospitals and to identify generally applicable findings and lessons for implementers.

### Methods

A systematic literature review of empirical research on EHR implementation was conducted. Databases used included Web of Knowledge, EBSCO, and Cochrane Library. Relevant references in the selected articles were also analyzed. Search terms included Electronic Health Record (and synonyms), implementation, and hospital (and synonyms). Articles had to meet the following requirements: (1) written in English, (2) full text available online, (3) based on primary empirical data, (4) focused on hospital-wide EHR implementation, and (5) satisfying established quality criteria.

### Results

Of the 364 initially identified articles, this study analyzes the 21 articles that met the requirements. From these articles, 19 interventions were identified that are generally applicable and these were placed in a framework consisting of the following three interacting dimensions: (1) EHR context, (2) EHR content, and (3) EHR implementation process.

## Conclusions

Although EHR systems are anticipated as having positive effects on the performance of hospitals, their implementation is a complex undertaking. This systematic review reveals reasons for this complexity and presents a framework of 19 interventions that can help overcome typical problems in EHR implementation. This framework can function as a reference for implementers in developing effective EHR implementation strategies for hospitals.

## Background

---

In recent years, Electronic Health Records (EHRs) have been implemented by an ever increasing number of hospitals around the world. There have, for example, been initiatives, often driven by government regulations or financial stimulations, in the USA [1], the United Kingdom [2] and Denmark [3]. EHR implementation initiatives tend to be driven by the promise of enhanced integration and availability of patient data [4], by the need to improve efficiency and cost-effectiveness [5], by a changing doctor-patient relationship toward one where care is shared by a team of health care professionals [5], and/or by the need to deal with a more complex and rapidly changing environment [6].

EHR systems have various forms, and the term can relate to a broad range of electronic information systems used in health care. EHR systems can be used in individual organizations, as interoperating systems in affiliated health care units, on a regional level, or nationwide [1, 2]. Health care units that use EHRs include hospitals, pharmacies, general practitioner surgeries, and other health care providers [7].

The implementation of hospital-wide EHR systems is a complex matter involving a range of organizational and technical factors including human skills, organizational structure, culture, technical infrastructure, financial resources, and coordination [8, 9]. As Grimson et al. [5] argue, implementing information systems (IS) in hospitals is more challenging than elsewhere because of the complexity of medical data, data entry problems, security and confidentiality concerns, and a general lack of awareness of the benefits of Information Technology (IT). Boonstra and Govers [10] provide three reasons why hospitals differ from many other industries, and these differences might also affect EHR implementations. The first reason is that hospitals have multiple objectives, such as curing and caring for patients, and educating new physicians and nurses. Second, hospitals have complicated and highly varied structures and processes. Third, hospitals have a varied workforce including medical professionals who possess high levels of expertise, power, and autonomy. These distinct characteristics justify a study that focuses on the identification and analysis of the findings of previous studies on EHR implementation in hospitals.

## Study aim, theoretical framework, and terminology

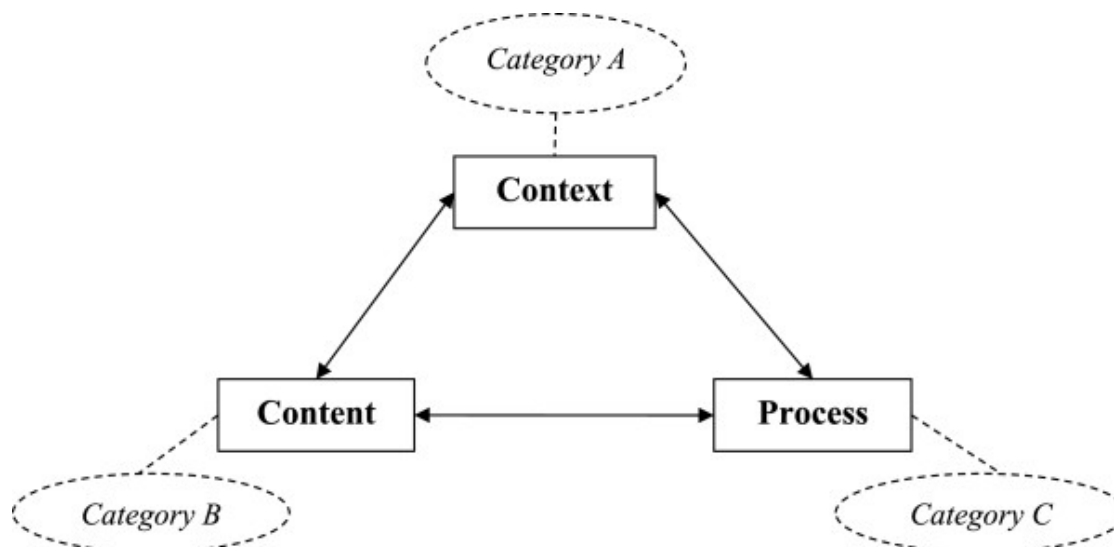
---

In dealing with the complexity of EHR implementation in hospitals, it is helpful to know which factors are seen as important in the literature and to capture the existing knowledge on EHR implementation in hospitals. As such, the objective of this research is to identify, categorize, and analyze the existing findings in the literature on EHR implementation processes in hospitals. This could contribute to greater insight into the underlying patterns and complex relationships involved in EHR implementation and could identify ways to tackle EHR implementation problems. In other words, this study focusses on the identification of factors that determine the progress of EHR implementation in hospitals. The motives behind implementing EHRs in hospitals and the effects on performance of implemented EHR systems are beyond the scope of this paper.

To our knowledge, there have been no systematic reviews of the literature concerning EHR implementation in hospitals and this article therefore fills that gap. Two interesting related review studies on EHR implementation are Keshavjee et al. [11] and McGinn et al. [12]. The study of Keshavjee et al. [11] develops a literature based integrative framework for EHR implementation. McGinn et al. [12] adopt an exclusive user perspective on EHR and their study is limited to Canada and countries with comparable socio-economic levels. Both studies are not explicitly focused on hospitals and include other contexts such as small clinics and national or regional EHR initiatives.

This systematic review is explicitly focused on hospital-wide, single hospital EHR implementations and identifies empirical studies (that include collected primary data) that reflect this situation. The categorization of the findings from the selected articles draws on Pettigrew's framework for understanding strategic change [13]. This model has been widely applied in case study research into organizational contexts [14], as well as in studies on the implementation of health care innovations [15]. It generates insights by analyzing three interactive dimensions – *context*, *content*, and *process* – that together shape organizational change. Pettigrew's framework [13] is seen as applicable because implementing an EHR artefact is an organization-wide effort. This framework was specifically selected for its focus on organizational change, its ease of understanding, and its relatively general dimensions allowing a broad range of findings to be included. The framework structures and focusses the analysis of the findings from the selected articles.

An organization's context can be divided into internal and external components. External context refers to the social, economic, political, and competitive environments in which an organization operates. The internal context refers to the structure, culture, resources, capabilities, and politics of an organization. The content covers the specific areas of the transformation under examination. In an EHR implementation, these are the EHR system itself (both hardware and software), the work processes, and everything related to these (e.g. social conditions). The process dimension concerns the processes of change, made up of the plans, actions, reactions, and interactions of the stakeholders, rather than work processes in general. It is important to note that Pettigrew [13] does not see strategic change as a rational analytical process but rather as an iterative, continuous, multilevel process. This highlights that the outcome of an organizational change will be determined by the context, content, and process of that change. The framework with its three categories, shown in Figure 1, illustrates the conceptual model used to categorize the findings of this systematic literature review.



[Figure 1](#)

Pettigrew's framework [13] and the corresponding categories.

In the literature, several terms are used to refer to electronic medical information systems. In this article, the term Electronic Health Record (EHR) is used throughout. Commonly used terms identified by ISO (the International Organization for Standardization) [16] plus another not identified by ISO are outlined below and used in our search. ISO considers Electronic Health Record (EHR) to be an overall term for “a repository of information regarding the health status of a subject of care, in computer processable form” [16], p. 13. ISO uses different terms to describe various types of EHRs. These include Electronic Medical Record (EMR), which is similar to an EHR but restricted to the medical domain. The terms Electronic Patient Record (EPR) and Computerized Patient Record (CPR) are also identified. Häyrynen et al. [17] view both terms as having the same meaning and referring to a system that contains clinical information from a particular hospital. Another term seen is Electronic Healthcare Record (EHCR) which refers to a system that contains all the available health information on a patient [17] and can thus be seen as synonymous with EHR [16]. A term often found in the literature is Computerized Physician Order Entry (CPOE). Although this term is not mentioned by ISO [16] or by Häyrynen et al. [17], we included CPOE for three reasons. First, it is considered by many to be a key hospital-wide function of an EHR system e.g. [8, 18]. Second, from a preliminary analysis of our initial results, we found that, from the perspective of the implementation process, comparable issues and factors emerged from both CPOEs and EHRs. Third, the implementation of a comprehensive electronic medical record requires physicians to make direct order entries [19]. Kaushal et al. define a CPOE as “a variety of computer-based systems that share the common features of automating the medication ordering process and that ensure standardized, legible, and complete orders” [18], p. 1410. Other terms found in the literature were not included in this review as they were considered either irrelevant or too broadly defined. Examples of such terms are Electronic Client Record (ECR), Personal Health Record (PHR), Digital Medical Record (DMR), Health Information Technology (HIT), and Clinical Information System (CIS).

## Methods

### Search strategies

In order for a systematic literature review to be comprehensive, it is essential that all terms relevant to the aim of the research are covered in the search. Further, we need to include relevant synonyms and related terms, both for electronic medical information systems and for hospitals. By adding an \* to the end of a term, the search engines pick out other forms, and by adding “ “ around words one ensures that only the complete term is searched for. Further, by including a ? as a wildcard character, every possible combination is included in the search.

The search used three categories of keywords. The first category included the following terms as approximate synonyms for hospital: “hospital\*”, “healthcare”, and “clinic\*”. The second category concerned implementation and included the term “implement\*”. For the third category, electronic medical information systems, the following search terms were used: “Electronic Health Record\*”, “Electronic Patient Record\*”, “Electronic Medical Record\*”, “Computerized Patient Record\*”, “Electronic Healthcare Record\*”, “Computerized Physician Order Entry”.

This relatively large set of keywords was necessary to ensure that articles were not missed in the search, and required a large number of search strategies to cover all those keywords. As we were seeking papers about the *implementation of electronic medical information systems in hospitals*, the search strategies included the terms shown in Table [1](#).

Table 1

**Overview of the search strategies**

Search strategy	Terms used**
[1]	“Electronic Health Record*” + implement* + hospital*
[2]	“Electronic Health Record*” + implement* + “health care”
[3]	“Electronic Health Record*” + implement* + clinic*
[4]	“Electronic Patient Record*” + implement* + hospital*
[5]	“Electronic Patient Record*” + implement* + “health care”
[6]	“Electronic Patient Record*” + implement* + clinic*
[7]	“Electronic Medical Record*” + implement* + hospital*
[8]	“Electronic Medical Record*” + implement* + “health care”
[9]	“Electronic Medical Record*” + implement* + clinic*
[10]	“Computeri?ed Patient Record*” + implement* + hospital*
[11]	“Computeri?ed Patient Record*” + implement* + “health care”
[12]	“Computeri?ed Patient Record*” + implement* + clinic*
[13]	“Electronic Health Care Record*” + implement* + hospital*
[14]	“Electronic Health Care Record*” + implement* + “health care”
[15]	“Electronic Health Care Record*” + implement* + clinic*
[16]	“Computeri?ed Physician Order Entry” + implement* + hospital*
[17]	“Computeri?ed Physician Order Entry” + implement* + “health care”
[18]	“Computeri?ed Physician Order Entry” + implement* + clinic*

[Open in a separate window](#)

*\*\*As suggested by the referees of this paper, we also used the terms “introduc\*” (instead of “implement\*”) and “provider” (instead of physician, as part of CPOE). Each of these two searches yielded one additional article.*

The following three search engines were chosen based on their relevance to the field and their accessibility by the researcher: Web of knowledge, EBSCO, and The Cochrane Library. Most search engines use several databases but not all of them were relevant for this research as they serve a wide range of fields. Appendix A provides an overview of the databases used. The reference lists included in articles that met the selection criteria were checked for other possibly relevant studies that had not been identified in the database search.

The articles identified from the various search strategies had to be academic peer-reviewed articles if they were to be included in our review. Further, they were assessed and had to satisfy the following criteria to be included: (1) written in English, (2) full text available online, (3) based on primary empirical data, (4) focused on hospital-wide EHR implementation, and (5) meeting established quality criteria. A long list of abstracts was generated, and all of them were independently reviewed by two of

the authors. They independently reviewed the abstracts, eliminated duplicates and shortlisted abstracts for detailed review. When opinions differed, a final decision over inclusion was made following a discussion between the researchers.

## Data analysis

The quality of the articles that survived this filtering was assessed by the first two authors using the Standard Quality Assessment Criteria for Evaluating Primary Research Papers [18]. In other words, the quality of the articles was jointly assessed by evaluating whether specific criteria had been addressed, resulting in a rating of 2 (fully addressed), 1 (partly addressed), or 0 (not addressed) for each criteria. Different questions are posed for qualitative and quantitative research and, in the event of a mixed-method study, both questionnaires were used. Papers were included if they received at least half of the total possible points, admittedly a relatively liberal cut-off point given comments in the Standard Quality Assessment Criteria for Evaluating Primary Research Papers [20].

The next step was to extract the findings of the reviewed articles and to analyze these with the aim of reaching general findings on the implementation of EHR systems in hospitals. Categorizing these general findings can increase clarity. The earlier introduced conceptual model, based on Pettigrew's framework for understanding strategic change, includes three categories: context (A), content (B), and process (C). As our review is specifically aimed at identifying findings related to the implementation process, possible motives for introducing such a system, as well as its effects and outcomes, are outside its scope. The authors held frequent discussions between themselves to discuss the meaning and the categorization of the general findings.

## Results

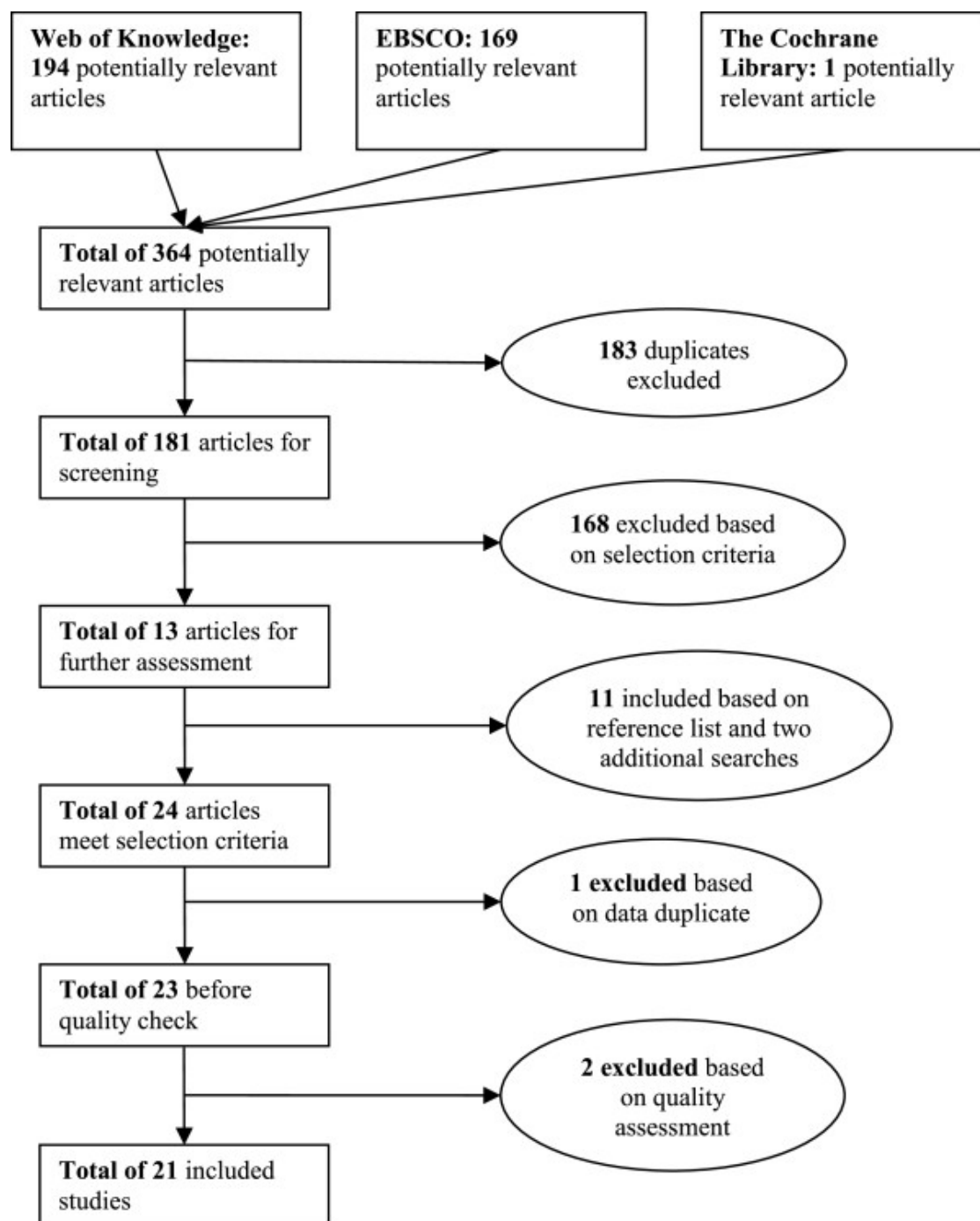
---

### Paper selection

Applying the 18 search strategies listed in Table 1 with the various search engines resulted in 364 articles being identified. The searches were carried out on 12 March 2013 for search strategies 1–15 and on 18 April 2013 for search strategies 16–18. The latter three strategies were added following a preliminary analysis of the first set of results which highlighted several other terms and descriptions for information technology in health care. Not surprisingly, many duplicates were included in the 364 articles, both within and between search engines. Using the Refworks functions for identifying exact and close duplicates, 160 duplicates were found. However, this procedure did not identify all the duplicates present and the second author carried out a manual check that identified an additional 23 duplicates. When removing duplicates, we retained the link to the first search engine that identified the article and, as the Web of Knowledge was the first search engine used, most articles appear to have stemmed from this search engine. This left 181 different articles which were screened on title and abstract to check whether they met the selection criteria. When this was uncertain, the contents of the paper were further investigated. This screening resulted in just 13 articles that met all the selection criteria. We then performed two additional checks for completeness. First, checking the references of these articles identified another nine articles. Second, as suggested by the referees of this paper, we also used the term “introduc\*” instead of “implement\*”, together with the other two original categories of terms, and the term “provider” instead of “physician”, as part of CPOE. Each of these two searches identified one additional article (see Table 1). Of these resulting 24 articles, two proved to be almost identical so one was excluded, resulting in 23 articles for a final quality assessment.

The results of the quality assessment can be found in Appendix B. The results show that two articles failed to meet the quality threshold and so 21 articles remained for in-depth analysis. Figure 2 displays the steps taken in this selection procedure.





[Open in a separate window](#)

**Figure 2**

Selection procedure.

To provide greater insight into the context and nature of the 21 remaining articles, an overview is provided in Table 2. All the studies except one were published after 2000. This reflects the recent increase in effort to implement organization-wide information systems, such as EHR systems, and also increasing incentives from governments to make use of EHR systems in hospitals. Of the 21 studies, 14 can be classified as qualitative, 6 as quantitative, and 1 as a mixed-method study. Most studies were conducted in the USA, with eight in various European countries. Teaching and non-teaching hospitals



are almost equally the subject of inquiry, and some researchers have focused on specific types of hospitals such as rural, critical access, or psychiatric hospitals. Ten of the articles were in journals with a five-year impact factor in the Journal Citation Reports 2011 database. There is a huge difference in the number of citations but one should never forget that newer studies have had fewer opportunities to be cited.

Table 2

Overview of studies included in the systematic literature review

Author	Country/region	Improved by enhancing and balancing Main objective of study knowledge	Type of research	Data collection	Participants (sample size, response rate)	Hospita type
		exploration and exploitation capabilities through the development of an EMR.				
Houser & Johnson [29]	USA/Alabama	1. To determine the status of implementation of EHRs in hospitals in the state of Alabama; 2. To assess the factors that are driving the decision making for implementation of EHRs; and 3. To assess the perceptions of HIM professionals of the benefits, barriers, and risks that are associated with implementation of EHRs.	Quantitative	Survey	131 directors in health information management, 69% response rate	Members of the Alabama Hospital Associati

[Open in a separate window](#)

*\*The 5-year impact factor based on the Journal Citation Reports 2011 is used in this table.*  
*\*\*The number of citations is identified using scholar.google.nl.*

Theoretical perspectives of reviewed articles

In research, it is common to use theoretical frameworks when designing an academic study [41]. Theoretical frameworks provide a way of thinking about and looking at the subject matter and describe the underlying assumptions about the nature of the subject matter [42]. By building on existing

theories, research becomes focused in aiming to enrich and extend the existing knowledge in that particular field [42]. To provide a more thorough understanding of the selected articles, their theoretical frameworks, if present, are outlined in Table 3.

Table 3

**Overview of the theoretical frameworks used in the included studies**

Author	Theoretical framework
Aarts et al. [21]	Three theoretical aspects: 1) sociotechnical approach, 2) emergent change with an unpredictable outcome, and 3) “success” and “failure” are socially negotiated judgments and is determined by the fit between work processes and information technology.
Aarts & Berg [22]	A model on success or failure of information systems with four variables: (1) information system, (2) support base, (3) medical work practices, and (4) hospital organization. Successful implementation of an information system (1) is defined as the capability to create a support base (2) for the change of (medical) work practices (3) induced by the system (4).
Ash et al. [23]	None
Ash et al. [24]	None
Boyer et al. [25]	None
Cresswell et al. [26]	Study draws on Actor-Network Theory, which helps to investigate how the centrally procured EHR has plays an active role in shaping social relationships.
Ford et al. [27]	HIT adoption strategies: (1) Single-vendor strategy, (2) Best of Breed strategy, and (3) Best of Suite strategy.
Gastaldi et al. [28]	The notion that the capability of any organization to create sustainable organizational value not only resides in the ownership of knowledge assets guaranteeing the present competitive advantage (knowledge exploitation), but also in the ability to understand and govern the continuous development of knowledge assets necessary to renew its organizational capabilities (knowledge exploitation).
Houser & Johnson [29]	None
Jaana et al. [30]	None
Katsma et al. [31]	IT implementation success is determined by quality (relevance) times acceptance (participation). Relevance is defined as the degree to which the user expects that the IT system will solve his problems or help to realize his actually relevant goals. Participation of employees is perceived to increase their acceptance of the IT system. Effectiveness of participation is moderated by

[Open in a separate window](#)

It is striking that no specific theoretical frameworks have been used in the research leading to 13 of the 21 selected articles. Most articles simply state their objective as gaining insight into certain aspects of EHR implementation (as shown in Table 1) and do not use a particular theoretical approach to identify and categorize findings. As such, these articles add knowledge to the field of EHR implementation but do not attempt to extend existing theories.

Aarts et al. [ 21 ] introducir la noción de enfoque sociotécnico: enfatizar la importancia de centrarse tanto en los aspectos sociales de una implementación de HME como en los aspectos técnicos del sistema. Utilizando el concepto de cambio emergente, argumentan que un proceso de implementación

está lejos de ser lineal y predecible debido a las contingencias y la complejidad organizativa que influye en el proceso. Un enfoque sociotécnico y el concepto de cambio emergente también se incluyen en el marco teórico de Takian et al. [ 37 ]. Aarts et al. [ 21 ] explique el enfoque sociotécnico al afirmar que el ajuste entre los procesos de trabajo y la tecnología de la información determina el éxito de la implementación. Aarts y Berg [ 22 ] introducir un modelo de éxito o fracaso en la implementación del sistema de información. Ven la creación de sinergia entre las prácticas de trabajo médico, el sistema de información y la organización del hospital según sea necesario para la implementación, y argumentan que esto solo sucederá si suficientes personas aceptan un cambio en las prácticas de trabajo. El estudio de Cresswell et al. [ 26 ] también está influenciado por los principios sociotécnicos y se basa en la teoría de la red de actores. Gastaldi et al. [ 28 ] perciben los registros electrónicos de salud como sistemas de gestión de conocimiento y cuestionan cómo pueden usarse dichos sistemas para desarrollar activos de conocimiento. Katsma et al. [ 31 ] centrarse en el éxito de la implementación y desarrollar la noción de que el éxito de la implementación está determinado por la calidad y la aceptación del sistema a través de la participación. Como tal, adoptan una visión más social sobre el éxito de la implementación en lugar de un enfoque sociotécnico. Rivard et al. [ 34 ] examinar las dificultades en la implementación de EHR desde una perspectiva cultural. No solo ven la cultura como un conjunto de supuestos compartidos por un colectivo completo (una perspectiva de integración) sino que también esperan que existan subculturas (una perspectiva de diferenciación), así como supuestos individuales no compartidos por un (sub) grupo específico (perspectiva de fragmentación). ). Ford et al. [ 27 ] se centran en un tema completamente diferente e investigan las estrategias de adopción de TI de los hospitales utilizando un marco que identifica tres estrategias. Estas son la estrategia de un solo proveedor (en la que todas las TI se adquieren de un solo proveedor), la mejor estrategia (integración de TI de múltiples proveedores) y la mejor estrategia (un enfoque híbrido que utiliza un enfoque focal). sistema de un proveedor como base más otras aplicaciones de otros proveedores).

Para resumir, los artículos de Aarts et al. [ 21 ], Aarts y Berg [ 22 ], Cresswell et al. [ 26 ], y Takian et al. [ 37 ] aplican un marco sociotécnico para enfocar su investigación. Gastaldi et al. [ 28 ] ver EHRs como un medio para renovar las capacidades organizativas. Katsma et al. [ 31 ] usar un marco social al enfocarse en la relevancia de un sistema de TI según lo percibe el usuario y la participación de los usuarios en el proceso de implementación. Rivard et al. [ 34 ] analiza cómo las culturas organizacionales pueden ser receptivas a la implementación de HME. Ford et al. [ 27 ] analice las estrategias de adopción, lo que los lleva a centrarse en el procedimiento de selección de registros médicos electrónicos. Los otros 13 estudios no usaron una lente teórica explícita en su investigación.

### Hallazgos relacionados con la implementación

El proceso de categorización comenzó evaluando si un hallazgo específico de un estudio debería ubicarse en la Categoría A, B o C. Treinta hallazgos se ubicaron en la Categoría A (contexto), 31 en la Categoría B (contenido) y 66 en la Categoría C (proceso). La comparación y combinación de los resultados específicos dio lugar a varios resultados generales dentro de cada categoría. Los hallazgos generales reciben un código (categoría carácter más número) y el código relacionado se indica junto con cada hallazgo específico en el Apéndice C. Los hallazgos que solo se vieron en un artículo, y por lo tanto carecían de apoyo, se descartaron.

### Categoría A - contexto

La categoría de contexto de un proceso de implementación de EHR incluye variables internas (como recursos, capacidades, cultura y políticas) y variables externas (como variables económicas, políticas y sociales). Se identificaron seis hallazgos generales, todos menos uno relacionado con variables internas. Un resumen de los hallazgos y artículos correspondientes se pueden encontrar en la Tabla 4 . La falta de resultados generales relacionados con las variables externas refleja nuestra decisión de excluir las razones subyacentes (por ejemplo, presiones políticas o sociales) para implementar un



sistema de HME de esta revisión. De manera similar, los hallazgos internos relacionados con aspectos tales como los beneficios financieros percibidos o la mejora de la calidad de la atención, están fuera de nuestro alcance.

**Tabla 4**

**Categoría A - Conclusiones del contexto**

Hallazgo general	Encontrando codigo	Números de artículo
Es más probable que los hospitales grandes (o afiliados al sistema), urbanos, sin fines de lucro y docentes hayan implementado un sistema de HME debido a tener mayores capacidades financieras, una mayor preparación para el cambio y una menor concentración en las ganancias.	A1	27/29/30/32
La implementación de EHR requiere la selección de un proveedor maduro que se comprometa a proporcionar un sistema que se ajuste a las necesidades específicas del hospital.	A2	28/32/33
La presencia de personal hospitalario con experiencia previa en tecnología de la información de salud aumenta la probabilidad de implementación de EHR ya que los usuarios finales experimentan menos incertidumbre.	A3	19/29/32/37/38
Una cultura organizacional que apoya la colaboración y el trabajo en equipo fomenta el éxito de la implementación de EHR porque la confianza entre los empleados es mayor.	A4	23/24/25/35
La implementación de EHR es más probable en una organización con poca burocracia y una flexibilidad considerable, ya que los cambios se pueden realizar rápidamente.	A5	19/25
La implementación del sistema EHR es difícil porque las actividades de cura y cuidado deben estar aseguradas en todo momento.	A6	28/34/39

A1: Es más probable que los hospitales grandes (o afiliados al sistema), urbanos, sin fines de lucro y docentes hayan implementado un sistema de HME debido a su mayor capacidad financiera, una mayor preparación para el cambio y una menor concentración en las ganancias

The research reviewed shows that larger or system-affiliated hospitals are more likely to have implemented an EHR system, and that this can be explained by their easier access to the large financial resources required. Larger hospitals have more financial resources than smaller hospitals [30] and system-affiliated hospitals can share costs [27]. Hospitals situated in urban areas more often have an EHR system than rural hospitals, which is attributed to less knowledge of EHR systems and less support from medical staff in rural hospitals [29]. The fact that not-for-profit hospitals more often have an EHR system fully implemented and teaching hospitals slightly more often than private hospitals is attributed to the latter's more wait-and-see approach and the more progressive change-ready nature of public and teaching hospitals [27, 32].

A2: EHR implementation requires the selection of a mature vendor who is committed to providing a system that fits the hospital's specific needs

Although this finding is not a great surprise, it is relevant to discuss it further. A hospital selecting its own vendor can ensure that the system will match the specific needs of that hospital [32]. Further, it is important to deal with a vendor that has proven itself on the EHR market with mature and successful products. The vendor must also be able to identify hospital workflows and adapt its product accordingly, and be committed to a long-term trusting relationship with the hospital [33]. With this in mind, the initial price of the system should not be the overriding consideration: the organization should be willing to avoid purely cost-oriented vendors [28], as costs soon mount if problems arise.

A3: The presence of hospital staff with previous experience of health information technology increases the likelihood of EHR implementation as less uncertainty is experienced by the end-users

In order to be able to work with an EHR system, users must be capable of using information technology such as computers and have adequate typing skills [19, 32]. Knowledge of, and previous experience with, EHR systems or other medical information systems reduces uncertainty and disturbance for users, and this results in a more positive attitude towards the system [29, 32, 37, 38].

A4: An organizational culture that supports collaboration and teamwork fosters EHR implementation success because trust between employees is higher

The influence of organizational culture on the success of organizational change is addressed in almost all the popular approaches to change management, as well as in several of the articles in this literature review. Ash et al. [23, 24] and Scott et al. [35] highlight that a strong culture with a history of collaboration, teamwork, and trust between different stakeholder groups minimizes resistance to change. Boyer et al. [25] suggest creating a favorable culture that is more adaptive to EHR implementation. However, creating a favorable culture is not necessarily easy: a comprehensive approach including incentives, resource allocation, and a responsible team was used in the example of Boyer et al. [25].

A5: EHR implementation is most likely in an organization with little bureaucracy and considerable flexibility as changes can be rapidly made

A highly bureaucratic organizational structure hampers change: it slows the process and often leads to inter-departmental conflict [19]. Specifically, appointing a multidisciplinary team to deal with EHR-related issues can prevent conflict and stimulate collaboration [25].

A6: EHR system implementation is difficult because cure and care activities must be ensured at all times

During the process of implementing an EHR system, it is of the utmost importance that all relevant information is always available [28, 34, 39]. Ensuring the continuity of quality care while implementing an EHR system is difficult and is an important distinction from many other IT implementations.

## Category B - content

The content of the EHR implementation process consists of the EHR system and the corresponding objectives, assumptions, and complementary services. Table 5 lists the five extracted general findings. These focus on both the hardware and software of the EHR system, and its relation to work practices and privacy.

Table 5

**Category B – Content findings**

General finding	Finding code	Article numbers
Creating a fit by adapting both the technology and work practices is a key factor in the implementation of EHR.	B1	19/21/26/28/31/37
Hardware availability and system reliability in terms of speed, availability, safety, and a lack of failures, are necessary to ensure EHR use.	B2	19/24/25/29/30/35/37/40
To ensure EHR implementation, the software needs to be user-friendly with regard to ease of use, efficiency in use, and functionality.	B3	19/24/32
An EHR implementation should contain adequate safeguards for patient privacy and confidentiality.	B4	25/29/37/40
EHR implementations require a vendor who is willing to adapt its product to hospital work processes.	B5	32/33

**B1: Creating a fit by adapting both the technology and work practices is a key factor in the implementation of EHR**

This finding elaborates on the sociotechnical approach identified in the earlier section on the theories adopted in the articles. Several authors [21, 26, 31, 37] make clear that creating a fit between the EHR system and the existing work practices requires an initial acknowledgement that an EHR implementation is not just a technical project and that existing work practices will change due to the new system. By customizing and adapting the system to meet specific needs, users will become more open to using it [19, 26, 28].

**B2: Hardware availability and system reliability, in terms of speed, availability, and a lack of failures, are necessary to ensure EHR use**

In several articles, authors highlight the importance of having sufficient hardware. A system can only be used if it is available to the users, and a system will only be used if it works without problems. Ash et al. [24], Scott et al. [35], and Weir et al. [19] refer to the speed of the system as well as to the availability of a sufficient number of adequate terminals see also [40] in various locations. Systems must be logically structured [29], reliable [32], and provide safe information access [37]. Boyer et al. [25] also mention the importance of technical aspects but add that these are not sufficient for EHR implementation.

**B3: To ensure EHR implementation, the software needs to be user-friendly with regard to ease of use, efficiency in use, and functionality**

Some authors distinguish between technical availability and reliability, and the user-friendliness of the software [19, 24, 32]. They argue that it is not sufficient for a system to be available and reliable, it should also be easy and efficient in use, and provide the functionality required for medical staff to give good care. If a system fails to do this, staff will not use the system and will stick to their old ways of working.

**B4: An EHR implementation should contain adequate safeguards for patient privacy and confidentiality**

Concerns over privacy and confidentiality are recognized by Boyer et al. [25] and Houser and Johnson [29] and are considered as a barrier to EHR implementation. Yoon-Flannery et al. [40] and Takian et al. [37] also recognize the importance of patient privacy and the need to address this issue by providing training and creating adequate safeguards.

**B5: EHR implementation requires a vendor who is willing to adapt its product to hospital work processes**

A vendor must be responsive and enable the hospital to develop its product to ensure a good and usable EHR system [32, 33]. By so doing, dependence on the vendor decreases and concerns that arise within the hospital can be addressed [32]. This finding is related to A2 in the sense that an experienced, cooperative, and flexible vendor is needed to deal with the range of interest groups found in hospitals.

**Category C - process**

This category refers to the actual process of implementing the EHR system. Variables considered are time, change approach, and change management. In our review, this category produced the largest number of general findings (see Table 6), as might be expected given our focus on the implementation process. EHR implementation often leads to anxiety, uncertainty, and concerns about a possible negative impact of the EHR on work processes and quality. The process findings, including leadership, resource availability, communication and participation are explicitly aimed at overcoming resistance to EHR implementation. These interventions help to create a positive atmosphere of goal directedness, co-creation and partnership.

Table 6

**Category C - Process findings**

General finding	Finding code	Article numbers
Due to their influential position, management's active involvement and support is positively associated with EHR implementation, and also counterbalances the physicians' medical dominance.	C1	19/24/25/32/33/34/35
Participation of clinical staff in the implementation process increases support for and acceptance of the EHR implementation.	C2	19/25/26/28/32/35/36
Training end-users and providing real-time support is important for EHR implementation success.	C3	19/29/32/36
A comprehensive implementation strategy, offering both clear guidance and room for emergent change, is needed for implementing an EHR system.	C4	19/21/25/26/28/31/37/40/36
Establishing an interdisciplinary implementation group consisting of developers, members of the IT department, and end-users fosters EHR implementation success.	C5	19/32/36
Resistance of clinical staff, in particular of physicians, is a major barrier to EHR implementation, but can be reduced by addressing their concerns.	C6	22/24/26/28/29/33/36
C7: Identifying champions among clinical staff reduces resistance.	C7	32/33/36
Assigning a sufficient number of staff and other resources to the EHR implementation process is important in adequately implementing the system.	C8	19/26/32/33/36

[Open in a separate window](#)

**C1: Due to their influential position, management's active involvement and support is positively associated with EHR implementation, and also counterbalances the physicians' medical dominance**

Several authors note the important role that managers play in EHR implementation. Whereas some authors refer to supportive leadership [19, 24], others emphasize that strong and active management involvement is needed [25, 32–35]. Strong leadership is relevant as it effectively counterbalances the physicians' medical dominance. For instance, Rivard et al. [34] observe that physicians' medical dominance and the status and autonomy of other health professionals hinder collaboration and teamwork, and that this complicates EHR implementation. Poon et al. [33] acknowledge this aspect and argue for strong leadership in order to deal with the otherwise dominant physicians. They also claim that leaders have to set an example and use the system themselves. At the same time, it is motivating that the implementation is managed by leaders who are recognized by the medical staff, for instance by head nurses and physicians or by former physicians and nurses [25, 33]. Ovretveit et al. [32] argue that it helps the implementation if senior management repeatedly declares the EHR implementation to be of the highest priority and supports this with sufficient financial and human resources. Poon et al. [33] add

to this by highlighting that, especially during uncertainties and setbacks, the common vision that guides the EHR implementation has to be communicated to hospital staff. Sufficient human resources include the selection of competent and experienced project leaders who are familiar with EHR implementation. Scott et al. [35] identify leadership styles for different phases: participatory leadership is valued in selection decisions, whereas a more hierarchical leadership style is preferable in the actual implementation.

#### C2: Participation of clinical staff in the implementation process increases support for and acceptance of the EHR implementation

Participation of end-users (the clinical staff) generates commitment and enables problems to be quickly solved [25, 26, 36]. Especially because it is very unlikely that the system will be perfect for all, it is important that the clinical staff become the owner, rather than customers, of the system. Clinical staff should participate at all levels and in all steps [19, 28, 32, 36] from initial system selection onwards [35]. Ovreteit et al. [32] propose that this involvement should have an extensive timeframe, starting in the early stages of implementation, when initial vendor requirements are formulated ('consultation before implementation'), through to the beginning of the use phase. Creating multidisciplinary work groups which determine the content of the EHR and the rules regarding the sharing of information contributes to EHR acceptance [25] and ensures realistic approaches acceptable to the clinical staff [36].

#### C3: Training end-users and providing real-time support is important for EHR implementation success

Frequently, the end-users of a new EHR system lack experience with the specific EHR system or with EHR systems in general. Although it is increasingly hard to imagine society or workplaces without IT, a large specific system, such as an EHR, still requires considerable training on how to use it properly. The importance of training is often underestimated, and inadequate training will create a barrier to EHR use [19, 29]. Consequently, adequate training, of appropriate quantity and quality, must be provided at the right times and locations [19, 32, 36]. Simon et al. [36] add to this the importance of real-time support, preferably provided by peers and super-users.

#### C4: A comprehensive implementation strategy, offering both clear guidance and room for emergent change, is needed for implementing an EHR system

Several articles highlight aspects of an EHR implementation strategy. A good strategy facilitates EHR implementation [19, 25] and consists of careful planning and preparation [36], a sustainable business plan, effective communication [28, 40] and mandatory implementation [19]. Emergent change is perceived as a key characteristic of EHR implementation in complex organizations such as hospitals [21], and this suggests an implementation approach based on a development paradigm [31], which may initially even involve parallel use of paper [26]. The notion of emergent change has been variously applied, including in the theoretical frameworks of Aarts et al. [21] and Katsma et al. [31]. These studies recognize that EHR implementation is relatively unpredictable due to unforeseen contingencies for which one cannot plan. With their emphasis on emergent change with unpredictable outcomes, Aarts et al. [21] make a case for acknowledging that unexpected and unplanned contingencies will influence the implementation process. They argue that the changes resulting from these contingencies often manifest themselves unexpectedly and must then be dealt with. Additionally, Takian et al. [37] state that it is crucial to contextualize an EHR implementation so as to be better prepared for unexpected changes.

#### C5: Establishing an interdisciplinary implementation group consisting of developers, members of the IT department, and end-users fosters EHR implementation success

In line with the arguments for management support and for the participation of clinical staff, Ovretveit et al. [32], Simon et al. [36] and Weir et al. [19] build a case for using an interdisciplinary implementation group. By having all the direct stakeholders working together, a better EHR system can be delivered faster and with fewer problems.

**C6: Resistance of clinical staff, in particular of physicians, is a major barrier to EHR implementation, but can be reduced by addressing their concerns**

Clinical staff's attitude is a crucial factor in EHR implementation [36]. Particularly, the physicians constitute an important group in hospitals. As such, their possible resistance to EHR implementation will form a major barrier [29, 33] and may lead to workarounds [26]. Whether physicians accept or reject an EHR implementation depends on their acceptance of their work practices being transformed [22]. The likelihood of acceptance will be increased if implementers address the concerns of physicians [24, 28, 32, 33], but also of other members of clinical staff [36].

**C7: Identifying champions among clinical staff reduces resistance**

The previous finding already elaborated on clinical staff resistance and suggested reducing this by addressing their concerns. Another way to reduce their resistance is related to the process of implementation and involves identifying physician champions, typically physicians that are well respected due to their knowledge and contacts [32, 33]. Simon et al. [36] emphasize the importance of identifying champions among each stakeholder group. These champions can provide reassurance to their peers.

**C8: Assigning a sufficient number of staff and other resources to the EHR implementation process is important in adequately implementing the system**

Implementing a large EHR system requires considerable resources, including human ones. Assigning appropriate people, such as super-users [36] and a sufficient number of them to that process will increase the likelihood of success [19, 32, 33, 36]. Further, it is important to have sufficient time and financial resources [26, 32]. This finding is also relevant in relation to finding A6 (ensuring good care during organizational change).

These 19 general findings have been identified from the individual findings within the 20 analyzed articles. These findings are all related to one of the three main and interacting dimensions of the framework: six to context, five to content, and eight to process. This identification and explanation of the general findings concludes the results section of this systematic literature review and forms the basis for the discussion below.

## Discussion

---

This review of the existing academic literature sheds light on the current knowledge regarding EHR implementation. The 21 selected articles all originate from North America or Europe, perhaps reflecting a greater governmental attention to EHR implementation in these regions and, of course, our inclusion of only articles written in English. Two articles were rejected for quality reasons [43, 44], see Appendix B. All but one of the selected articles have been published since 2000, reflecting the growing interest in implementing EHR systems in hospitals. Eight articles built their research on a theoretical framework, four of which use the same general lens of the sociotechnical approach [21, 22, 26, 37]. Katsma et al. [31] and Rivard et al. [34] focus more on the social and cultural aspects of EHR implementation, the former on the relevance for, and participation of, users, the latter on three different cultural perspectives. Ford et al. [27] researched adoption strategies for EHR systems and Gastaldi et



al. [26] consider them as a means to renew organizational capabilities. It is notable that the other reviewed articles did not use a theoretical framework to analyze EHR implementation and made no attempt to elaborate on existing theories.

A total of 127 findings were extracted from the articles, and these findings were categorized using Pettigrew's framework for strategic change [13] as a conceptual model including the three dimensions of context, content, and process. To ensure a tight focus, the scope of the review was explicitly limited to findings related to the EHR implementation process, thus excluding the reasons for, barriers to, and outcomes of an EHR implementation.

Some of the findings require further interpretation. Contextual finding A1 relates to the demographics of a hospital. One of the assertions is that privately owned hospitals are less likely than public hospitals to invest in an EHR. The former apparently perceive the costs of EHR implementation to outweigh the benefits. This seems remarkable given that there is a general belief that information technology increases efficiency and reduces process costs, so more than compensating for the high initial investments. It is however important to note that the literature on EHR is ambivalent when it comes to efficiency; several authors record a decrease in the efficiency of work practices [25, 33, 35, 38], whereas others mention an increase [29, 31]. Finding A2 is a reminder of the importance of carefully selecting an appropriate vendor, taking into account experience with the EHR market and the maturity of their products rather than, for example, focussing on the cost price of the system. Given the huge investment costs, the price of an EHR system tends to have a major influence on vendor selection, an aspect that is also promoted by the current European tendering regulations that oblige (semi-) public institutions, like many hospitals, to select the lowest bidder, or the bidder that is economically the most preferable [45]. The finding that EHR system implementation is difficult because good medical care needs to be ensured at all times (A6) also deserves mention. Essentially, many system implementations in hospitals are different from IT implementations in other contexts because human lives are at stake in hospitals. This not only complicates the implementation process because medical work practices have to continue, it also requires a system to be reliable from the moment it is launched.

The findings regarding the content of the EHR system (Category B) highlight the importance of a suitable software product. A well-defined selection process of the software package and its associated vendor (discussed in A2) is seen as critical (B5). Selection should be based on a careful requirements analysis and an analysis of the experience and quality of the vendor. An important requirement is a sufficient degree of flexibility to customize and adapt the software to meet the needs of users and the work practices of the hospital (finding B1). At the same time the software product should challenge the hospital to rethink and improve its processes. A crucial condition for the acceptance by the diverse user groups of hospitals is the robustness of the EHR system in terms of availability, speed, reliability and flexibility (B2). This also requires adequate hardware in terms of access to computers, and mobile equipment to enable availability at all the locations of the hospital. Perceived ease of use of the system (B4) and the protection of patients' privacy (B4) are other content factors that can make or break EHR implementation in hospitals.

The findings on the implementation process, our Category C, highlight four aspects that are commonly mentioned in change management approaches as important success factors in organizational change. The active involvement and support of management (C1), the participation of clinical staff (C2), a comprehensive implementation strategy (C4), and using an interdisciplinary implementation group (C5) correspond with three of the ten guidelines offered by Kanter et al. [46]. These three guidelines are: (1) support a strong leader role; (2) communicate, involve people, and be honest; and (3) craft an implementation plan. As the implementation of an EHR system is an organizational change process it is no surprise that these commonalities are identified in several of the analyzed articles. Three Category C findings (C2, C6, and C7) concern dealing with clinical staff given their powerful positions and potential resistance. Physicians are the most influential medical care providers, and their resistance can

delay an EHR implementation [23], lead to at least some of it being dropped [21, 22, 34], or to it not being implemented at all [33]. Thus, there is ample evidence of the crucial importance of physicians' acceptance of an EHR for it to be implemented. This means that clinicians and other key personnel should be highly engaged and motivated to contribute to EHR. Prompt feedback on requests, and high quality support during the implementation, and an EHR that clearly supports clinical work are key issues that contribute to a motivated clinical staff.

Analyzing and comparing the findings enables us to categorize them in terms of subject matter (see Table 7). By categorizing the findings in terms of subject, and by totaling the number of articles related to the individual findings on that subject, one can deduce how much attention has been given in the literature to the different topics. This analysis highlights that the involvement of physicians in the implementation process, the quality of the system, and a comprehensive implementation strategy are considered the crucial elements in EHR implementation.

**Table 7**

**Findings sorted by subject**

Subject	Related findings	Nr. of articles
Leadership and involvement in the process	C1, C2, C5, C8	10
Vendor	A2, B5	3
Implementation strategy	C4, C5,	10
Role of clinical staff (in particular the physicians)	C6, C7,	8
Users' skills/experience	A3, C3	6
EHR system	B2, B3	8
Patient issues	A6, B4,	7
Hospital demographics	A1	4
Organizational culture	A4	4
Organizational structure	A5	2
Fit between work processes and EHR system	B1	6

Notwithstanding the useful results, this review and analysis has some limitations. Although we carefully developed and executed the search strategy, we cannot be sure that we found all the relevant articles. Since we focused narrowly on keywords, and these had to be part of an article's title, we could have excluded relevant articles that used different terminology in their titles. Although searching the reference lists of identified articles did result in several additional articles, some relevant articles might still have been missed. Another limitation is the exclusion of publications in languages other than English. Further, the selection and categorization of specific findings, and the subsequent extraction of general findings, is subjective and depends on the interpretations of the authors, and other researchers might have made different choices. A final limitation is inherent to literature reviews in that the authors of the studies included may have had different motives and aims, and used different methods and interpretative means, in drawing their conclusions.

## Conclusions

---

The existing literature fails to provide evidence of there being a comprehensive approach to implementing EHR systems in hospitals that integrates relevant aspects into an ‘EHR change approach’. The literature is diffuse, and articles seldom build on earlier ones to increase the theoretical knowledge on EHR implementation, notable exceptions being Aarts et al. [21], Aarts and Berg [22], Cresswell et al. [26], and Takian et al. [37]. The earlier discussion on the various results summarizes the existing knowledge and reveals gaps in the knowledge associated with EHR implementation. The number of EHR implementations in hospitals is growing, as well as the body of literature on this subject. This systematic review of the literature has produced 19 general findings on EHR implementation, which were each placed in one of three categories. A number of these general findings are in line with the wider literature on change management, and others relate to the specific nature of EHR implementation in hospitals.

The findings presented in this article can be viewed as an overview of important subjects that should be addressed in implementing an EHR system. It is clear that EHR systems have particular complexities and should be implemented with great care, and with attention given to context, content, and process issues and to interactions between these issues. As such, we have achieved our research goal by creating a systematic review of the literature on EHR implementation. This paper’s academic contribution is in providing an overview of the existing literature with regard to important factors in EHR implementation in hospitals. Academics interested in this specific field can now more easily access knowledge on EHR implementation in hospitals and can use this article as a starting point and build on the existing knowledge. The managerial contribution lies in the general findings that can be applied as guidelines when implementing EHR in hospitals. We have not set out to provide a single blueprint for implementing an EHR system, but rather to provide guidelines and to highlight points that deserve attention. Recognizing and addressing these aspects can increase the likelihood of getting an EHR system successfully implemented.

## Appendix

---

### Appendix A - List of databases

This appendix provides an overview of all databases included in the used search engines. The databases in *italic* were excluded for the research as these databases focus on fields not relevant for the subject of EHR implementations.

#### Web of Knowledge

- 1) Web of Science
- 2) Biological Abstracts
- 3) Inspec
- 4) MEDLINE
- 5) Journal Citation Reports

#### EBSCO

- 1) Academic Search Premier
- 2) AMED - The Allied and Complementary Medicine Database
- 3) *America: History & Life*
- 4) *American Bibliography of Slavic and East European Studies*
- 5) *Arctic & Antarctic Regions*
- 6) *Art Full Text (H.W. Wilson)*

- 7) *Art Index Retrospective (H.W. Wilson)*
- 8) *ATLA Religion Database with ATLASerials*
- 9) *Business Source Premier*
- 10) *CINAHL*
- 11) *Communication & Mass Media Complete*
- 12) *eBook Collection (EBSCOhost)*
- 13) *EconLit*
- 14) *ERIC*
- 15) *Funk & Wagnalls New World Encyclopedia*
- 16) *GreenFILE*
- 17) *Historical Abstracts*
- 18) *L'Année philologique*
- 19) *Library, Information Science & Technology Abstracts*
- 20) *MAS Ultra - School Edition*
- 21) *MEDLINE*
- 22) *Military & Government Collection*
- 23) *MLA Directory of Periodicals*
- 24) *MLA International Bibliography*
- 25) *New Testament Abstracts*
- 26) *Old Testament Abstracts*
- 27) *Philosopher's Index*
- 28) *Primary Search*
- 29) *PsycARTICLES*
- 30) *PsycBOOKS*
- 31) *PsycCRITIQUES*
- 32) *Psychology and Behavioral Sciences Collection*
- 33) *PsycINFO*
- 34) *Regional Business News*
- 35) *Research Starters - Business*
- 36) *RILM Abstracts of Music Literature*
- 37) *SocINDEX*

### The Cochrane Library

- 1) *Cochrane Database of Systematic Reviews*
- 2) *Cochrane Central Register of Controlled Trials*
- 3) *Cochrane Methodology Register*
- 4) *Database of Abstracts of Reviews of Effects*
- 5) *Health Technology Assessment Database*
- 6) *NHS Economic Evaluation Database*
- 7) *About The Cochrane Collaboration*

### Appendix B - Quality assessment

The quality of the articles was assessed with the Standard Quality Assessment Criteria for Evaluating Primary Research Papers [18]. Assessment was done by questioning whether particular criteria had been addressed, resulting in a rating of 2 (completely addressed), 1 (partly addressed), or 0 (not addressed) points. Table 8 provides the overview of the scores of the articles, (per question) for qualitative studies; Table 9 for quantitative studies; and Table 10 for mixed methods studies. Articles were included if they scored 50% or higher of the total amount of points possible. Based on this assessment, two articles were excluded from the search.

Table 8

**Quality assessment results of qualitative studies**

<b>Criteria qualitative studies</b>	<a href="#">[21]</a>	<a href="#">[22]</a>	<a href="#">[24]</a>	<a href="#">[25]</a>	<a href="#">[26]</a>	<a href="#">[28]</a>	<a href="#">[31]</a>	<a href="#">[32]</a>	<a href="#">[33]</a>	<a href="#">[34]</a>	<a href="#">[35]</a>	<a href="#">[36]</a>
Question/objective sufficiently described?	2	2	2	2	2	2	2	2	1	2	1	2
Study design evident and appropriate?	2	2	2	2	2	2	2	2	2	2	2	2
Context for the study clear?	2	2	2	2	2	2	1	2	1	2	1	2
Connection to a theoretical framework/wider body of knowledge?	2	1	0	2	1	0	2	2	0	2	1	0
Sampling strategy described, relevant and justified?	0	0	2	2	2	2	1	0	1	2	1	2
Data collection methods clearly described and systematic?	1	1	2	2	2	2	1	2	2	1	1	2
Data analysis clearly described and systematic?	0	0	1	1	1	2	0	1	1	2	1	2
Use of verification procedure (s) to establish credibility?	0	2	2	0	1	1	0	0	0	0	0	1
Conclusions supported by the results?	1	2	2	2	2	0	1	2	2	2	2	2

[Open in a separate window](#)

Table 9

**Quality assessment results of quantitative studies**

<b>Criteria quantitative studies</b>	<b>[27]</b>	<b>[29]</b>	<b>[30]</b>	<b>[44]</b>	<b>[38]</b>	<b>[39]</b>	<b>[19]</b>
Question/objective sufficiently described?	2	2	2	1	2	2	2
Study design evident and appropriate?	2	2	2	1	2	2	2
Method of subject/comparison group selection or source of information/input variables described and appropriate?	1	2	1	1	2	1	2
Subject (and comparison group, if applicable) characteristics sufficiently described?	2	2	2	1	2	2	1
If interventional and random allocation was possible, was it described?	N/A	N/A	N/A	N/A	N/A	N/A	N/A
If interventional and blinding of investigators was possible, was it reported?	N/A	N/A	N/A	N/A	N/A	N/A	N/A
If interventional and blinding of subjects was possible, was it reported?	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Outcome and (if applicable) exposure measure (s) well defined and robust to measurement/misclassification bias?	0	2	1	0	2	2	2
Means of assessment reported?							
Sample size appropriate?	2	2	2	2	2	2	2
Analytic methods described/justified and appropriate?	1	1	2	0	0	1	2
Some estimate of variance is reported for the main results?	1	0	2	0	1	1	N/A
Controlled for confounding?	2	1	2	0	1	1	N/A
Results reported in sufficient detail?	2	2	2	1	2	2	2
Conclusions supported by the results?	1	2	2	2	2	2	2
Total score/possible maximum score	<b>16/22</b>	<b>19/22</b>	<b>20/22</b>	<b>9/22</b>	<b>18/22</b>	<b>18/22</b>	<b>17/18</b>

[Open in a separate window](#)

Table 10

**Quality assessment results of mixed methods studies**

<b>Qualitative criteria mixed methods studies</b>	<b>[23]</b>	<b>[43]</b>
Question/objective sufficiently described?	1	2
Study design evident and appropriate?	2	2
Context for the study clear?	2	1
Connection to a theoretical framework/wider body of knowledge?	0	1
Sampling strategy described, relevant and justified?	1	0
Data collection methods clearly described and systematic?	1	1
Data analysis clearly described and systematic?	1	0
Use of verification procedure (s) to establish credibility?	0	0
Conclusions supported by the results?	1	1
Reflexivity of the account?	0	0
<b>Quantitative criteria mixed methods studies</b>		
Question/objective sufficiently described?	1	2
Study design evident and appropriate?	2	2
Method of subject/comparison group selection or source of information/input variables described and appropriate?	2	1
Subject (and comparison group, if applicable) characteristics sufficiently described?	1	0
If interventional and random allocation was possible, was it described?	N/A	N/A
If interventional and blinding of investigators was possible, was it reported?	N/A	N/A
If interventional and blinding of subjects was possible, was it reported?	N/A	N/A
Outcome and (if applicable) exposure measure (s) well defined and robust to measurement/misclassification bias? Means of assessment reported?	2	0
Sample size appropriate?	2	N/A
Analytic methods described/justified and appropriate?	2	0
Some estimate of variance is reported for the main results?	1	0
Controlled for confounding?	N/A	N/A
Results reported in sufficient detail?	2	0
Conclusions supported by the results?	2	1
<b>Total score/possible maximum score</b>	<b>26/40</b>	<b>14/38</b>

[Open in a separate window](#)

**Appendix C - All findings**

Table 11 displays all findings from the selected articles. The category number is related to the general finding as discussed in the Results section.



Table 11  
Overview of all findings

Author	Findings	Category
Ash et al. [23]	Trust between administrators and physicians seems to be a necessary ingredient tot successful implementation.	A4
Ash et al. [24]	Organizational issue fostering implementation: a strong culture	A4
Ash et al. [24]	Organizational issue fostering implementation: a history of collaboration and teamwork	A4
Boyer et al. [25]	A favorable strategic factor is creating a favorable organizational culture.	A4
Boyer et al. [25]	The establishment of a multidisciplinary team to deal with her related issues prevents conflict and stimulates collaboration.	A5
Ford et al. [27]	For-profit hospitals are half as likely to have fully implemented an EHR as their nonprofit counterparts.	A1
Ford et al. [27]	System-affiliated hospitals were 31 percent more likely than were unaffiliated facilities to have successfully implemented an EHR.	A1
Gastaldi et al. [28]	Willingness to avoid pure cost-oriented vendors.	A2
Gastaldi et al. [28]	Diffused pressures to realize the EMR as soon as possible, because physicians' data sharing is needed.	A6
Houser & Johnson [29]	Rural hospitals are less likely to have completed implementation of an EHR system compared to urban and suburban hospitals.	A1
Houser & Johnson [29]	Government-owned or not-for-profit hospitals more often implemented a complete EHR system compared to for-profit hospitals.	A1
Houser & Johnson [29]	A perceived barrier of implementing an EHR system is the lack of knowledge of EHR systems.	A3
Jaana et al. [30]	Critical Access Hospitals (CAH) in Iowa have significantly lower EMR levels compared to non-CAHs.	A1
Jaana et al. [30]	A higher number of staffed beds and available slack resources is positively associated with higher clinical IS scores and EMR levels.	A1
Ovretveit	A facilitating factor in implementing an EMR system is the local hospital control of	A2

[Open in a separate window](#)

## Acknowledgement

We acknowledge the Master degree program Change Management at the University of Groningen for supporting this study. We also thank the referees for their valuable comments.

## Footnotes

### Competing interests

The authors declare that they have no competing interests.

## Authors' contributions

AB and JV established the research design and made significant contributions to the interpretation of the results. They supervised AV throughout the study, and participated in writing the final version of this paper. AV contributed substantially to the selection and analysis of included papers, and wrote a preliminary draft of this article. All authors have read and approved the final manuscript.

## Contributor Information

---

Albert Boonstra, Email: [albert.boonstra@rug.nl](mailto:albert.boonstra@rug.nl).

Arie Versluis, Email: [aversluis@deloitte.nl](mailto:aversluis@deloitte.nl).

Janita F J Vos, Email: [j.f.j.vos@rug.nl](mailto:j.f.j.vos@rug.nl).

## References

---

1. Abramson EL, McGinnis S, Edwards A, Maniccia DM, Moore J, Kaushal R. Electronic health record adoption and health information exchange among hospitals in New York State. *J Eval Clin Pract.* 2011;18:1156–1162. doi: 10.1111/j.1365-2753.2011.01755.x. [[PubMed](#)] [[CrossRef](#)]
2. Robertson A, Cresswell K, Takian A, Petrakaki D, Crowe S, Cornford T, Sheikh A. Implementation and adoption of nationwide electronic health records in secondary care in England: qualitative analysis of interim results from a prospective national evaluation. *Br Med J.* 2010;341:c4564. doi: 10.1136/bmj.c4564. [[PMC free article](#)] [[PubMed](#)] [[CrossRef](#)]
3. Rigsrevisionen . Extract from the report to the Public Accounts Committee on the implementation of electronic patient records at Danish hospitals. 2011.
4. Hartswood M, Procter R, Rouncefield M, Slack R. Making a Case in Medical Work: Implications for the Electronic Medical Record. *Comput Supported Coop Work.* 2003;12:241–266. doi: 10.1023/A:1025055829026. [[CrossRef](#)]
5. Grimson J, Grimson W, Hasselbring W. The SI Challenge in Health Care. *Commun ACM.* 2000;43(6):49–55. doi: 10.1145/336460.336474. [[CrossRef](#)]
6. Mantzana V, Themistocleous M, Irani Z, Morabito V. Identifying healthcare actors involved in the adoption of information systems. *Eur J Inf Syst.* 2007;16:91–102. doi: 10.1057/palgrave.ejis.3000660. [[CrossRef](#)]
7. Boonstra A, Boddy D, Bell S. Stakeholder management in IOS projects: analysis of an attempt to implement an electronic patient file. *Eur J Inf Syst.* 2008;17(2):100–111. doi: 10.1057/ejis.2008.2. [[CrossRef](#)]
8. Jha A, DesRoches CM, Campbell EG, Donelan K, Rao SR, Ferris TF, Shields A, Rosenbaum S, Blumenthal D. Use of Electronic Health Records in US hospitals. *N Engl J Med.* 2009;360:1628–1638. doi: 10.1056/NEJMsa0900592. [[PubMed](#)] [[CrossRef](#)]
9. Heeks R. Health information systems: Failure, success and improvisation. *Int J Med Inform.* 2006;75:125–137. doi: 10.1016/j.ijmedinf.2005.07.024. [[PubMed](#)] [[CrossRef](#)]
10. Boonstra A, Govers MJ. Understanding ERP system implementation in a hospital by analysing stakeholders. *N Technol Work Employ.* 2009;24(2):177–193. doi: 10.1111/j.1468-005X.2009.00227.x. [[CrossRef](#)]

11. Keshavjee K, Bosomworth J, Copen J, Lai J, Kucukyazici B, Liani R, Holbrook AM. Proceed of the 11th International Symposium on Health Information Mangement Research – iSHIMR. 2006. Best practices in EMR implementation: a systematic review; pp. 1–15.
12. McGinn CA, Grenier S, Duplantie J, Shaw N, Sicotte C, Mathieu L, Leduc Y, Legare F, Gagnon MP. Comparison of use groups perspectives of barriers and facilitator to implementing EHR – a systematic review. *BMC Med*. 2011;9:46. doi: 10.1186/1741-7015-9-46. [[PMC free article](#)] [[PubMed](#)] [[CrossRef](#)]
13. Pettigrew AM. Context and action in the transformation of the firm. *J Manag Stud*. 1987;24(6):649–670. doi: 10.1111/j.1467-6486.1987.tb00467.x. [[CrossRef](#)]
14. Hartley J. Case Study Research. Chapter 26. In: Cassel C, Symon G, editors. *Essential Guide to Qualitative Methods in Organizational Research*. London: Sage; 2004.
15. Hage E, Roo JP, Offenbeek MAG, Boonstra A. Implementation factors and their effect on e-health service adoption in rural communities: a systematic literature review. *BMC Health Serv Res*. 2013;13(19):1–16. [[PMC free article](#)] [[PubMed](#)]
16. ISO: Health informatics . Draft Tech Report. 2004. Electronic health record - Definition, scope and context; pp. 03–16.
17. Häyrynen K, Saranto K, Nykänen P. Definition, structure, content, use and impacts of electronic health records: A review of the research literature. *Int J Med Inform*. 2008;77:291–304. doi: 10.1016/j.ijmedinf.2007.09.001. [[PubMed](#)] [[CrossRef](#)]
18. Kaushal R, Shojania KG, Bates DW. Effects of computerized physician order entry and clinical decision support systems on medication safety: a systematic review. *Arch Intern Med*. 2003;163(12):1409–1416. doi: 10.1001/archinte.163.12.1409. [[PubMed](#)] [[CrossRef](#)]
19. Weir C, Lincoln M, Roscoe D, Turner C, Moreshead G. Dimensions associated with successful implementation of a hospital based integrated order entry system. *Proc Annu Symp Comput Appl [Sic] in Med Care Symp Comput Appl Med Care*. 1994;653:7. [[PMC free article](#)] [[PubMed](#)]
20. Kmet LM, Lee RC, Cook LS. Standard quality assessment criteria for evaluating primary research papers from a variety of fields. 2004.
21. Aarts J, Doorewaard H, Berg M. Understanding implementation: The case of a computerized physician order entry system in a large dutch university medical center. *J Am Med Inform Assoc*. 2004;11(3):207–216. doi: 10.1197/jamia.M1372. [[PMC free article](#)] [[PubMed](#)] [[CrossRef](#)]
22. Aarts J, Berg M. Same systems, different outcomes - Comparing the implementation of computerized physician order entry in two Dutch hospitals. *Methods Inf Med*. 2006;45(1):53–61. [[PubMed](#)]
23. Ash J, Gorman P, Lavelle M, Lyman J, Fournier L. Investigating physician order entry in the field: lessons learned in a multi-center study. *Stud Health Technol Inform*. 2001;84(2):1107–1111. [[PubMed](#)]
24. Ash JS, Gorman PN, Lavelle M, Payne TH, Massaro TA, Frantz GL, Lyman JA. A cross-site qualitative study of physician order entry. *J Am Med Inform Assoc*. 2003;10(2):188–200. doi: 10.1197/jamia.M770. [[PMC free article](#)] [[PubMed](#)] [[CrossRef](#)]
25. Boyer L, Samuelian J, Fieschi M, Lancon C. Implementing electronic medical records in a psychiatric hospital: A qualitative study. *Int J Psychiatry Clin Pract*. 2010;14(3):223–227. doi: 10.3109/13651501003717243. [[PubMed](#)] [[CrossRef](#)]

26. Cresswell KM, Worth A, Sheikh A. Integration of a nationally procured electronic health record system into user work practices. *BMC Med Inform Decis Mak.* 2012;12:15. doi: 10.1186/1472-6947-12-15. [[PMC free article](#)] [[PubMed](#)] [[CrossRef](#)]
27. Ford EW, Menachemi N, Huerta TR, Yu F. Hospital IT Adoption Strategies Associated with Implementation Success: Implications for Achieving Meaningful Use. *J Healthc Manag.* 2010;55(3):175–188. [[PubMed](#)]
28. Gastaldi L, Lettieri E, Corso M, Masella C. Performance improvement in hospitals: leveraging on knowledge assets dynamics through the introduction of an electronic medical record. *Meas Bus Excell.* 2012;16(4):14–30. doi: 10.1108/13683041211276410. [[CrossRef](#)]
29. Houser SH, Johnson LA. Perceptions regarding electronic health record implementation among health information management professionals in Alabama: a statewide survey and analysis. *Perspect Health Inf Manage/AHIMA, Am Health Inf Manage Assoc.* 2008;5:6–6. [[PMC free article](#)] [[PubMed](#)]
30. Jaana M, Ward MM, Bahensky JA. EMRs and Clinical IS Implementation in Hospitals: A Statewide Survey. *J Rural Health.* 2012;28:34–43. doi: 10.1111/j.1748-0361.2011.00386.x. [[PubMed](#)] [[CrossRef](#)]
31. Katsma CP, Spil TAM, Ligt E, Wassenaar A. Implementation and use of an electronic health record: measuring relevance and participation in four hospitals. *Int J Healthc Technol Manag.* 2007;8(6):625–643. doi: 10.1504/IJHTM.2007.014194. [[CrossRef](#)]
32. Ovretveit J, Scott T, Rundall TG, Shortell SM, Brommels M. Improving quality through effective implementation of information technology in healthcare. *Int J Qual Health Care.* 2007;19(5):259–266. doi: 10.1093/intqhc/mzm031. [[PubMed](#)] [[CrossRef](#)]
33. Poon EG, Blumenthal D, Jaggi T, Honour MM, Bates DW, Kaushal R. Overcoming barriers to adopting and implementing computerized physician order entry systems in US hospitals. *Health Aff.* 2004;23(4):184–190. doi: 10.1377/hlthaff.23.4.184. [[PubMed](#)] [[CrossRef](#)]
34. Rivard S, Lapointe L, Kappos A. An Organizational Culture-Based Theory of Clinical Information Systems Implementation in Hospitals. *J Assoc Inf Syst.* 2011;12(2):123–162.
35. Scott JT, Rundall TG, Vogt TM, Hsu J. Kaiser Permanente's experience of implementing an electronic medical record: a qualitative study. *Br Med J.* 2005;331(7528):1313–1316. doi: 10.1136/bmj.38638.497477.68. [[PMC free article](#)] [[PubMed](#)] [[CrossRef](#)]
36. Simon SR, Keohane CA, Amato M, Coffey M, Cadet M, Zimlichman E. Lessons learned from implementation of computerized provider order entry in 5 community hospitals: a qualitative study. *BMC Med Inform Decis Mak.* 2013;13:67. doi: 10.1186/1472-6947-13-67. [[PMC free article](#)] [[PubMed](#)] [[CrossRef](#)]
37. Takian A, Sheikh A, Barber N. We are bitter, but we are better off: case study of the implementation of an electronic health record system into a mental health hospital in England. *BMC Health Serv Res.* 2012;12:484. doi: 10.1186/1472-6963-12-484. [[PMC free article](#)] [[PubMed](#)] [[CrossRef](#)]
38. Ward MM, Vartak S, Schwichtenberg T, Wakefield DS. Nurses' Perceptions of How Clinical Information System Implementation Affects Workflow and Patient Care. *Cin-Comput Inform Nurs.* 2011;29(9):502–511. doi: 10.1097/NCN.0b013e31822b8798. [[PubMed](#)] [[CrossRef](#)]
39. Ward MM, Vartak S, Loes JL, O'Brien J, Mills TR, Halbesleben JRB, Wakefield DS. CAH Staff Perceptions of a Clinical Information System Implementation. *Am J Manage Care.* 2012;18(5):244–252. [[PubMed](#)]

40. Yoon-Flannery K, Zandieh SO, Kuperman GJ, Langsam DJ, Hyman D, Kaushal R. A qualitative analysis of an electronic health record (EHR) implementation in an academic ambulatory setting. *Inform Prim Care*. 2008;16(4):277–284. [[PubMed](#)]
41. Van Aken J, Berends H, Van der Bij H. Problem solving in organizations. New York, USA: Cambridge University Press; 2012.
42. Botha ME. Theory development in perspective: the role of conceptual frameworks and models in theory development. *J Adv Nurs*. 1989;14(1):49–55. doi: 10.1111/j.1365-2648.1989.tb03404.x. [[PubMed](#)] [[CrossRef](#)]
43. Spetz J, Keane D. Information Technology Implementation in a Rural Hospital: A Cautionary Tale. *J Healthc Manag*. 2009;54(5):337–347. [[PubMed](#)]
44. Massaro TA. Introducing Physician Order Entry at a Major Academic Medical-Center. *Impact Organ Culture Behav Acad Med*. 1993;68(1):20–25. [[PubMed](#)]
45. Lundberg S, Bergman M. Tender evaluation and supplier selection methods in public procurement. *J Purch Supply Manage*. 2013;19(2):73–83. doi: 10.1016/j.pursup.2013.02.003. [[CrossRef](#)]
46. Kanter RM, Stein BA, Jick TD. The Challenge of Organizational Change. New York, USA: Free Press; 1992.

### Pre-publication history

1. The pre-publication history for this paper can be accessed here: <http://www.biomedcentral.com/1472-6963/14/370/prepub>

---

Articles from BMC Health Services Research are provided here courtesy of **BioMed Central**