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Review article

Successfully implementing a national electronic health record: a rapid umbrella review

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\textbf{ABSTRACT}

\textbf{Aim:} To summarize the findings from literature reviews with a view to identifying and exploring the key factors which impact on the success of an EHR implementation across different healthcare contexts.

\textbf{Introduction:} Despite the widely recognised benefits of electronic health records (EHRs), their full potential has not always been achieved, often as a consequence of the implementation process. As more countries launch national EHR programmes, it is critical that the most up-to-date and relevant international learnings are shared with key stakeholders.

\textbf{Methods:} A rapid umbrella review was undertaken in collaboration with a multidisciplinary panel of knowledge-users and experts from Ireland. A comprehensive literature review was completed (2019) across several search engines (PubMed, CINAHL, Scopus, Embase, Web of Science, IEEE Xplore, ACM Digital Library, ProQuest, Cochrane) and Gray literature. Identified studies (n = 5,040) were subject to eligibility criterion and identified barriers and facilitators were analysed, reviewed, discussed and interpreted by the expert panel.

\textbf{Results:} Twenty-seven literature reviews were identified which captured the key organizational, human and technological factors for a successful EHR implementation according to various stakeholders across different settings. Although the size, type and culture of the healthcare setting impacted on the organizational factors, each was deemed important for EHR success; Governance, leadership and culture, End-user involvement, Training, Support, Resourcing, and Workflows. As well as organizational differences, individual end-users have varying Skills and characteristics, Perceived benefits and incentives, and Perceived changes to the health ecosystem which were also critical to success. Finally, the success of the EHR technology depended on Usability, Interoperability, Adaptability, Infrastructure, Regulation, standards and policies, and Testing.

\textbf{Conclusion:} Fifteen inter-linked organizational, human and technological factors emerged as important for successful EHR implementations across primary, secondary and long-term care settings. In determining how to employ these factors, the local context, individual end-users and advancing technology must also be considered.

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1. Introduction

Capturing and effectively using clinical information and knowledge to ensure a quality, safe and sustainable healthcare service is widely recognised as important [1,2] and data from electronic health records (EHRs) have been vital to decision-making on public health policies during the COVID-19 pandemic [3]. An EHR provides a longitudinal record of information regarding the health status of an individual in computer-processible form across practices and specialists, and enables authorised access to clinical records in real-time [4,5]. As well as expanding the capacity to utilise clinical data for monitoring of patient outcomes and conducting audits and research [6,7], the EHR provides access to patient information in a timely manner, enabling healthcare professionals (HCPs) to spend more time with patients 1, reducing duplication of tests and work, and improving the safety and quality of care provided [4,7,9-14]. Additionally, integration of other functions and software, such as clinical decision support and bar code medication administration, further expand its potential benefits [3,5,16].

Electronic patient records (EPRs) or electronic medical records (EMRs) also offer many of these benefits but solely contain the records from an individual organization. Whilst shared or summary care records and patient portals respectively store and facilitate access to specific patient information required by HCPs and patients [17]. Despite the number of benefits which can be derived from these systems, challenges have been met in implementing a fully interoperable EHR between primary and secondary care [13,19], often attributed to the implementation process as opposed to the product supplied by the EHR vendor [20,21]. Therefore, the implementation process is critical [22] and must be considered as an ongoing process beginning during procurement and continuing throughout each phase of design, development, testing, ‘Go Live’ and optimization.

Whilst hospital information systems (HIS) in the USA have been in existence since the 1960s [23], HIS are a more recent phenomenon in the Republic of Ireland where public healthcare is managed by the Health Service Executive (HSE) which co-exists with a private health system. The Office of the Chief Information Officer (CIO) has overall responsibility for embedding technology within the health infrastructure [24] and to date, EPRs have been implemented in some individual private and public hospitals and the majority of general practitioner (GP) offices (i.e., private care physicians often with HSE contracts), as well as for specific cohorts of patients (e.g., maternal and newborn, and epilepsy) [25]. However, many other hospitals and HSE primary care (i.e., community) centres remain largely paper-based. With an EHR in the pipeline [24,26], three national projects have been planned by eHealth Ireland which is led by the Office of the CIO; Acute EHR, Community EHR and the Shared and Integrated Care Record. Therefore, this is an opportune time for policy-makers and other key stakeholders to review the learnings from the implementations of health information technology (HIT) both in Ireland and internationally.

However, a vast amount of literature is published on topics such as EHRs which renders it difficult for policy-makers to remain up-to-date [27,28], perhaps amplifying the ‘know-do’ gap. Additionally, healthcare is a complex and adaptive system which needs to be recognized and acknowledged when attempting to replicate successes in another context [29]. The EHR programme in Ireland is also already underway and therefore, it’s critical that knowledge is generated to provide actionable and relevant key considerations in a timely manner aligned with the policy and decision-making cycles [30]. Therefore, the aim of this review is to identify and explore the key factors which promote a successful EHR implementation across healthcare settings, with active collaboration from key stakeholders in the Irish context.

| Table 1 |
| --- |
| Positions held by the members of the Expert Panel (n = 10). |
| National Clinical Information Officer for Nursing and Midwifery, HSE. |
| Professor of Health Informatics, UCD. |
| Group Chief Information Officer, Ireland East Hospital Group, HSE. |
| ICT Project Manager, Office of the Clinical Information Officer, HSE. |
| Senior Clinical Psychologist, National Rehabilitation Hospital, Dublin. |
| National Clinical Information Officer for Nursing and Midwifery, HSE. |
| Community EHR Senior Project Manager, HSE. |
| General Practitioner (GP). |
| National Co-ordinator of the GPIT Project at the Irish College of General Practitioners. |
| Senior Professional Officer, National Co-ordinator of the GPIT Project at the Irish College of General Practitioners. |
| National Co-ordinator of the GPIT Project at the Irish College of General Practitioners. |
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Note: Some members of the expert panel had more than one position. Health Service Executive (HSE), government-funded organisation responsible for the provision of health and personal social services; UCD, University College Dublin; Ireland East Hospital Group, one of seven hospital groups in Ireland comprising of 11 hospitals and four community healthcare organisations; ICT, Information Communication Technology; Maternal and Newborn Clinical Management System (MN-CMS), an EHR for all women and babies being cared for across maternity and new born services in Ireland; GPIT, General Practice Information Technology; EPR, Electronic Patient Record.

2. Methods

2.1. Design

A rapid umbrella review was conducted and guided by the World Health Organisation (WHO) practical guide for Rapid Reviews to Strengthen Health Policy and Systems [31]. Unlike a systematic review, an umbrella review also known as a review of reviews, compiles evidence from several research syntheses across different healthcare contexts and stakeholder groups [32,33]. Active collaboration with an expert panel of knowledge users facilitated the acceleration of the systematic review process [36] and to facilitate uptake and use of these findings by planners and decision-makers, the synthesized findings were also presented in a report format [34].

2.2. Expert panel of knowledge users

A multi-disciplinary panel of experts and knowledge users (n = 10) were engaged and involved throughout the review process to inform its methodology, validate the generalizability and relevance of the review findings [35], and ensure it reflects current thinking and is useful [27]. The panel was convened in January 2019 by the Office of Nursing and Midwifery Services Director (HSE) and comprised of those currently involved in large HIT implementation projects across primary and secondary care at local and national levels in Ireland, as well as clinicians, health service researchers and academic partners from healthcare and health informatic backgrounds (Table 1). Five consultative in-person group meetings and several individual meetings and email exchanges within the group were conducted throughout the review process.

2.3. Research question and search strategy

An initial exploratory scope of the EHR literature in the PubMed database was reviewed by the expert panel and the final research question, methodology and search strategy were developed and agreed. A large number of search terms to describe “Electronic Health Record”, “Implementation” and “Literature Review” were identified from previous systematic reviews [7,36-40], additional literature [17], medical subject heading and controlled vocabulary and via consultation with the
expert panel and an experienced information technologist at the Health Sciences Library, UCD [Appendix]. The search string was tailored to the indexing language of each database and in March 2019, it was executed across PubMed, CINAHL, Scopus, Embase, Web of Science, IEEE Xplore, ACM Digital Library, ProQuest and Cochrane, with limitations of English language and published since 2010. Grey literature including reports and conference proceedings were also searched (international Health Informatics Societies, the World Health Organization (WHO), European e-health network, Kings Fund, Gartner and Lenus). Panellists also drew on their expertise to identify any additional relevant sources [35].

2.4. Identification of literature reviews

Identified articles were calibrated in the citation management software Endnote version x9.2 and titles and abstracts were screened by one researcher using the inclusion and exclusion criteria agreed with the expert panel (Table 2). Full text articles were then accessed and screened by the same researcher, with any doubts regarding inclusion or exclusion discussed with the panel to overcome any risk of errors or inconsistencies associated with using one reviewer [31]. In line with our chosen rapid review methodology, a quality assessment of identified reviews was not conducted.

2.5. Data extraction and synthesis

A standardized data extraction form was developed and included authors, year of publication, study design, participants, healthcare setting, included studies and findings related to factors impacting on the implementation (i.e., themes and/or paragraphs as required). Following data extraction, a qualitative content analysis of the factors impacting on the EHR implementation was undertaken by the researcher [41]. Using an iterative process, a list of codes representing the identified factors from each of the literature reviews was formed [42]. The expert panel reviewed these codes via an adapted nominal group technique, which saw collated appraisals distributed amongst the panellists [43] to assess whether they were comprehensive of the literature and their own experiences, and to determine whether the findings could be transferred to Irish contexts and settings [42]. Having reached a final consensus regarding the factors for a successful EHR implementation, these factors were further categorized into a theoretical framework [10] and resulted in the generation of key considerations [42].

3. Results

3.1. Characteristics of literature reviews

Of the 5,040 articles retrieved, 27 literature reviews were identified which captured factors deemed important for the successful implementation of EHRs, as well as other HIT implementations (Fig. 1). Fifteen were classified as systematic reviews, whilst the others were umbrella reviews (n = 3), scoping reviews (n = 2), interpretive review (n = 1), literature review with a meta-narrative (n = 1) and other non-systematic literature reviews (n = 5). Overlap in included publications existed across the literature reviews with 974 unique studies, literature reviews
Table 3
Identified literature reviews which reviewed the key factors for a successful EHR implementation.

| Author (Year)          | Design                          | Focus                                | Setting/participants                                    | Studies | Inclusion criteria | Identified factors                                                                 | Identified factors                                                                 |
|------------------------|---------------------------------|--------------------------------------|---------------------------------------------------------|---------|--------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|
| Ajami and Bagheri-tadi [12] | Non-systematic review           | Barriers to EHR adoption             | Physicians in hospital or community                      | 20      | n/a                | Governance, leadership and culture                                                  | Skills and characteristics                                                             |
|                        |                                 |                                      |                                                          |         |                    | Vendor trust & experience                                                          | Computer literacy & skill                                                            |
|                        |                                 |                                      |                                                          |         |                    | Communication among users                                                          | Ability to select & effectively install system                                       |
|                        |                                 |                                      |                                                          |         |                    | Training                                                                           | Perceived benefits and incentives                                                    |
|                        |                                 |                                      |                                                          |         |                    | Support                                                                            | Lack of incentives                                                                   |
|                        |                                 |                                      |                                                          |         |                    | Resourcing                                                                          | Perceived changes to the health ecosystem                                           |
|                        |                                 |                                      |                                                          |         |                    | Workflows                                                                           | Concerns about data entry, patient acceptance, security & privacy                   |
|                        |                                 |                                      |                                                          |         |                    | Workflow development                                                               | Interfaces with healthcare setting or doctor-patient relationship                   |
|                        |                                 |                                      |                                                          |         |                    | Process change                                                                     | Support                                                                            |
|                        |                                 |                                      |                                                          |         |                    | Training                                                                           | Executive management                                                                |
|                        |                                 |                                      |                                                          |         |                    | Resourcing                                                                          | Process change                                                                     |
|                        |                                 |                                      |                                                          |         |                    | Workflows                                                                           | IT resources & cost                                                                 |
|                        |                                 |                                      |                                                          |         |                    | Perceived benefits and incentives                                                  | Economic competitiveness                                                             |
|                        |                                 |                                      |                                                          |         |                    | End-user involvement                                                                | Support                                                                            |
|                        |                                 |                                      |                                                          |         |                    | IT alignment with firm strategy                                                     | Motivation to collaborate                                                           |
|                        |                                 |                                      |                                                          |         |                    | Governance, leadership and culture                                                  | Accessibility & usability                                                             |
|                        |                                 |                                      |                                                          |         |                    | Firm strategy                                                                       | Interoperability                                                                   |
|                        |                                 |                                      |                                                          |         |                    | Scope & project controls                                                           | IT integration with external networks                                               |
|                        |                                 |                                      |                                                          |         |                    | Interactions across communities                                                    | Infrastructure                                                                     |
|                        |                                 |                                      |                                                          |         |                    | Motivation to collaborate                                                           | IT innovation                                                                      |
|                        |                                 |                                      |                                                          |         |                    | Culture change                                                                      | System Architecture & Infrastructure                                               |
|                        |                                 |                                      |                                                          |         |                    | Knowledge management                                                                | Regulations, standards and policies                                                 |
|                        |                                 |                                      |                                                          |         |                    | Process change                                                                      | Shared language & narratives                                                         |
|                        |                                 |                                      |                                                          |         |                    | End-user involvement                                                                | Interoperability                                                                   |
|                        |                                 |                                      |                                                          |         |                    | IT alignment with firm strategy                                                     | Perceived changes to healthcare ecosystem                                           |
|                        |                                 |                                      |                                                          |         |                    |                                                                                   | Ensuring care activities                                                             |
|                        |                                 |                                      |                                                          |         |                    |                                                                                   | Usability                                                                          |
|                        |                                 |                                      |                                                          |         |                    |                                                                                   | User-friendly software                                                              |
|                        |                                 |                                      |                                                          |         |                    |                                                                                   | Adequate safeguards                                                                |
| Ben-Zion et al. [52]   | Literature review and prescriptive analysis | Success factors for EHR adoption | No restriction on healthcare setting or participants identified | 55      | 2001-2013 English  | Governance, leadership and culture                                                  | Infrastructure                                                                     |
|                        |                                 |                                      |                                                          |         |                    | Firm strategy                                                                       | System Architecture & Infrastructure                                               |
|                        |                                 |                                      |                                                          |         |                    | Scope & project controls                                                           | Regulations, standards and policies                                                 |
|                        |                                 |                                      |                                                          |         |                    | Interactions across communities                                                    | Shared language & narratives                                                         |
|                        |                                 |                                      |                                                          |         |                    | Motivation to collaborate                                                           | Interoperability                                                                   |
|                        |                                 |                                      |                                                          |         |                    | Culture change                                                                      | Perceived changes to healthcare ecosystem                                           |
|                        |                                 |                                      |                                                          |         |                    | Knowledge management                                                                | Ensuring care activities                                                             |
|                        |                                 |                                      |                                                          |         |                    | Process change                                                                      | Usability                                                                          |
|                        |                                 |                                      |                                                          |         |                    | End-user involvement                                                                | User-friendly software                                                              |
|                        |                                 |                                      |                                                          |         |                    | IT alignment with firm strategy                                                     | Adequate safeguards                                                                |
|                        |                                 |                                      |                                                          |         |                    | Governance, leadership and culture                                                  | Infrastructure                                                                     |
|                        |                                 |                                      |                                                          |         |                    | Firm strategy                                                                       | System Architecture & Infrastructure                                               |
|                        |                                 |                                      |                                                          |         |                    | Scope & project controls                                                           | Regulations, standards and policies                                                 |
|                        |                                 |                                      |                                                          |         |                    | Interactions across communities                                                    | Shared language & narratives                                                         |
|                        |                                 |                                      |                                                          |         |                    | Motivation to collaborate                                                           | Interoperability                                                                   |
|                        |                                 |                                      |                                                          |         |                    | Culture change                                                                      | Perceived changes to healthcare ecosystem                                           |
|                        |                                 |                                      |                                                          |         |                    | Knowledge management                                                                | Ensuring care activities                                                             |
|                        |                                 |                                      |                                                          |         |                    | Process change                                                                      | Usability                                                                          |
|                        |                                 |                                      |                                                          |         |                    | End-user involvement                                                                | User-friendly software                                                              |
|                        |                                 |                                      |                                                          |         |                    | IT alignment with firm strategy                                                     | Adequate safeguards                                                                |
| Boonstra et al. [36]   | Systematic review               | EHR implementation lessons            | Project team, doctors, nurses, technical & clerical personnel, administrators, IT personnel, psychiatrists, directors, CEOs, CIOs, managers, vendors, healthcare practitioners, pharmacists in hospitals | 21      | Up until 2013 English Peer-reviewed Empirical | Governance, leadership and culture                                                  | Support                                                                            |
|                        |                                 |                                      |                                                          |         |                    | Firm strategy                                                                       | Real-time support management                                                       |
|                        |                                 |                                      |                                                          |         |                    | Scope & project controls                                                           | Support                                                                            |
|                        |                                 |                                      |                                                          |         |                    | Interactions across communities                                                    | Financial capabilities                                                             |
|                        |                                 |                                      |                                                          |         |                    | Motivation to collaborate                                                           | Sufficient number of staff                                                          |
|                        |                                 |                                      |                                                          |         |                    | Culture change                                                                      | Workflows                                                                           |
|                        |                                 |                                      |                                                          |         |                    | Knowledge management                                                                | System fitting hospital’s needs                                                       |
|                        |                                 |                                      |                                                          |         |                    | Process change                                                                      | Creating a fit by adapting technology & work                                       |
|                        |                                 |                                      |                                                          |         |                    | End-user involvement                                                                | Skills and characteristics                                                           |
|                        |                                 |                                      |                                                          |         |                    | IT alignment with firm strategy                                                     | Previous experience of HIT                                                          |
|                        |                                 |                                      |                                                          |         |                    |                                                                                   | Resistance of clinical staff                                                       |
|                        |                                 |                                      |                                                          |         |                    |                                                                                   |                                                                                   |
| Boonstra et al. [53]   | Systematic review               | Barriers to acceptance of EMRs       | Physicians in any healthcare organisations              | 22      | 1998-2009          | Governance, leadership and culture                                                  | Resourcing                                                                         |
|                        |                                 |                                      |                                                          |         |                    | Vendor uncertainty                                                                  | Start-up & ongoing costs                                                            |
|                        |                                 |                                      |                                                          |         |                    | Lack of participation                                                               | Time to select, learn & convert patient records                                    |
|                        |                                 |                                      |                                                          |         |                    |                                                                                   |                                                                                   |

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| Author                    | Design            | Focus                                      | Setting/participants                                      | Studies  | Inclusion criteria | Identified factors                                                                 |
|--------------------------|-------------------|--------------------------------------------|-----------------------------------------------------------|----------|--------------------|-----------------------------------------------------------------------------------|
| Castillo et al. [11]     | Systematic review | EHR adoption                               | Physicians in inpatients & outpatients in hospitals & primary care | 68       | 1985-2010 English | General, leadership, and culture                                                  |
|                          |                   |                                            |                                                           |          |                    | Communication among users                                                          |
|                          |                   |                                            |                                                           |          |                    | Lead professional support                                                          |
| Cresswell and Sheikh [44]| Interpretive review | Organisational barriers to HIT implementation and adoption | No restriction on healthcare setting or participants identified | 13       | 1997-2010 Systematic reviews | Governance, leadership, and culture                                               |
|                          |                   |                                            |                                                           |          |                    | Open communication channels                                                        |
|                          |                   |                                            |                                                           |          |                    | Senior leadership & “champion”                                                     |
|                          |                   |                                            |                                                           |          |                    | Strong organizational leadership & management                                      |
|                          |                   |                                            |                                                           |          |                    | Avoidance of “scope creep”                                                        |
|                          |                   |                                            |                                                           |          |                    | Appropriate implementation approach                                               |
|                          |                   |                                            |                                                           |          |                    | Plan for potentially extreme contingencies                                         |
|                          |                   |                                            |                                                           |          |                    | End-user involvement                                                              |
|                          |                   |                                            |                                                           |          |                    | On-going involvement of key stakeholders                                           |
|                          |                   |                                            |                                                           |          |                    | Support                                                                        |
|                          |                   |                                            |                                                           |          |                    | Governance, leadership, and culture                                               |
|                          |                   |                                            |                                                           |          |                    | Ownership & size of practice                                                       |
|                          |                   |                                            |                                                           |          |                    | Training                                                                       |
|                          |                   |                                            |                                                           |          |                    | Support                                                                        |
|                          |                   |                                            |                                                           |          |                    | Cost                                                                           |
|                          |                   |                                            |                                                           |          |                    | Governing, leadership, and culture                                               |
|                          |                   |                                            |                                                           |          |                    | Political                                                                        |
|                          |                   |                                            |                                                           |          |                    | Organizational                                                                   |
|                          |                   |                                            |                                                           |          |                    | Training                                                                       |
|                          |                   |                                            |                                                           |          |                    | Cost                                                                           |
| De Grood et al. [55]     | Scoping review     | Barriers to and opportunities for e-health technology adoption | Physicians in any healthcare organisations | 74       | 1995-2015          | Lack of time & workload                                                          |
|                          |                   |                                            |                                                           |          |                    | Perceived benefits and incentives                                                 |
|                          |                   |                                            |                                                           |          |                    | Pre-analysis of data                                                             |
|                          |                   |                                            |                                                           |          |                    | Proof of utility                                                                 |
|                          |                   |                                            |                                                           |          |                    | Perceived changes to healthcare ecosystem                                         |
|                          |                   |                                            |                                                           |          |                    | Financial                                                                       |
|                          |                   |                                            |                                                           |          |                    | Perceived changes to the healthcare ecosystem                                    |
|                          |                   |                                            |                                                           |          |                    | Ethical                                                                         |
|                          |                   |                                            |                                                           |          |                    | Workflows                                                                      |
|                          |                   |                                            |                                                           |          |                    | Skills and characteristics                                                        |
|                          |                   |                                            |                                                           |          |                    | Perceived benefits and incentives                                                 |
|                          |                   |                                            |                                                           |          |                    | Perceived changes to healthcare ecosystem                                         |
|                          |                   |                                            |                                                           |          |                    | User attitude                                                                    |
|                          |                   |                                            |                                                           |          |                    | Interoperability                                                                 |
|                          |                   |                                            |                                                           |          |                    | Interoperability                                                                 |
|                          |                   |                                            |                                                           |          |                    | Interoperability                                                                 |
|                          |                   |                                            |                                                           |          |                    | Interoperability                                                                 |
|                          |                   |                                            |                                                           |          |                    | Adaptability                                                                    |
|                          |                   |                                            |                                                           |          |                    | Testing                                                                         |
|                          |                   |                                            |                                                           |          |                    | Perceived benefits of use                                                          |
|                          |                   |                                            |                                                           |          |                    | Supports inter-professional roles and working                                    |
|                          |                   |                                            |                                                           |          |                    | Interoperability                                                                 |
|                          |                   |                                            |                                                           |          |                    | Interoperability                                                                 |
|                          |                   |                                            |                                                           |          |                    | Adaptability                                                                    |
|                          |                   |                                            |                                                           |          |                    | Testing                                                                         |
|                          |                   |                                            |                                                           |          |                    | Field testing of early prototypes                                                |
| Fritz et al. [48]        | Systematic review  | Success criteria for EMR implementation     | Hospital or community in low resource countries            | 47       | English            | Governance, leadership, and culture                                               |
|                          |                   |                                            |                                                           |          |                    | Political                                                                       |
|                          |                   |                                            |                                                           |          |                    | Organizational                                                                   |
|                          |                   |                                            |                                                           |          |                    | Training                                                                       |
|                          |                   |                                            |                                                           |          |                    | Cost                                                                           |
| Gagnon et al. [49]       | Systematic review  | Barriers and facilitators to implementing   | Physicians, nurses, other HCPs, admin,                     | 34       | Empirical Design e. | Lack of time & workload                                                          |
|                          |                   |                                            |                                                           |          |                    | Perceived benefits and incentives                                                 |
|                          |                   |                                            |                                                           |          |                    | Pre-analysis of data                                                             |
|                          |                   |                                            |                                                           |          |                    | Proof of utility                                                                 |
|                          |                   |                                            |                                                           |          |                    | Perceived changes to healthcare ecosystem                                         |
|                          |                   |                                            |                                                           |          |                    | Financial                                                                       |
|                          |                   |                                            |                                                           |          |                    | Perceived changes to the healthcare ecosystem                                    |
|                          |                   |                                            |                                                           |          |                    | Ethical                                                                         |
|                          |                   |                                            |                                                           |          |                    | Workflows                                                                      |
|                          |                   |                                            |                                                           |          |                    | Skills and characteristics                                                        |
|                          |                   |                                            |                                                           |          |                    | Perceived benefits and incentives                                                 |
|                          |                   |                                            |                                                           |          |                    | Perceived changes to healthcare ecosystem                                         |

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Table 3 (continued)

| Author         | Design                  | Focus                                      | Setting/ participants                                           | Studies | Inclusion criteria | Identified factors                                                                 |
|----------------|-------------------------|--------------------------------------------|----------------------------------------------------------------|---------|-------------------|-----------------------------------------------------------------------------------|
| Gesulga et al. | Structured literature review | Barriers to the implementation of adoption of EHR or EMR readiness | No restriction on healthcare setting or participants identified | 38 English | Until July 2016 | Privacy and security concerns, Patient/clinician interaction, Autonomy, Impact on professional security, Usability, Design, Content appropriate & satisfactory, Generic substitution options, Data accuracy & legibility, Ease of use, Efficiency, Patient security, Interoperability, Infrastructure, System reliability or dependability |
| Gill et al.    | Scoping review           | Adoption of EHRs or EMRs                   | No restriction on healthcare setting or participants identified | 39 Case studies | English 2010-2015 | Affects physician-patient interaction, Concerns about privacy & confidentiality, Physicians’ legal liability, Usability, User access limitation, Data accuracy & quality, Capacity to use real-time data, Infrastructure, Centralized, National health information network, Data Security, Hardware, functionality issues, Internet connectivity, Network communication infrastructure, Network speed, Lack of IT facilities & equipment, Regulations, standards and policies, Lack of health information data standards, Health terminology & classification, Risk of new regulatory requirements, Usability, System designed & built as per requirements |
| Kruse et al.   | Systematic review        | Facilitators & barriers to the             | Public health                                                  | 55 2012-2017 English |             | Complex, Ease of use (continued on next page)                                      |
| Author (Year) | Design | Focus | Setting/ participants | Studies | Inclusion criteria | Identified factors |
|--------------|--------|-------|-----------------------|---------|-------------------|-------------------|
| **Kruse et al.** [51] | Systematic review | Barriers to EHR adoption | Any patient care facility in the USA | 21 | 2012-2016 English | Culture, Communication, Support, Resourcing, Skills and characteristics, Resistance to change, Perceived benefits and incentives, Governance, leadership and culture, Training, Support, Initial & maintenance/ongoing costs, Effort needed to select system, Staff shortages, Productivity loss, Workflow challenges | Critical thinking/treatment decisions, Quality, Surveillance, Preventative care, Decision support, Health outcomes, Perceived changes to the healthcare ecosystem, Privacy concerns, Usability | Accessibility/utilization, Satisfaction, Data management/MISSING data & errors, Efficiency, Interoperability, Regulations, standards and policies, No standards, Infrastructure, Current technology |
| **Kruse et al.** [50] | Systematic review | Barriers & facilitators to EHR adoption | Any patient care facility in the USA | 36 (31 unique) | 2012-2015 | Governance, leadership and culture, Implementation issues, External factors, Organizational, Hospital size, Project planning, Strategy, Competitiveness, Communication, Training, Support, Executive management, Support, Resourcing, Cost | Time-consuming, Lack of tech assistance, Staff shortages/overworked, Skills and characteristics, User/patient resistance, Lack of tech experience, Race & income disparities, Provider or patient age, User acceptance, IMGs less likely to adopt, Perceived benefits and incentives, Financial incentives, Return on investment, Perceived usefulness, Penalties, Medical errors, Perceived changes to the healthcare ecosystem, Privacy concerns, Physician autonomy | Usability, Transition of data, Access to patient data, Efficiency, Privacy & security, Interoperability, Ability to transfer information, Continuity of care, Infrastructure upgrades, Lack of infrastructure, space for systems, Adaptability, Lack of agility to make changes, Regulations, standards and policies, Standard protocols for data exchange |
| Author                  | Design                     | Focus                                      | Setting/ participants | Studies | Inclusion criteria | Identified factors                                                                                                                                                                                                 |
|-------------------------|----------------------------|--------------------------------------------|-----------------------|---------|--------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Kruse et al. [46]       | Systematic review          | Adoption factors for EHR introduction     | LTC                   | 22      | 2009-2014 English USA-based | Governance, leadership and culture  
Project planning  
Facility characteristics  
Implementation issues  
Cultural change  
External factors  
Training  
Implementation issues  
Perceived changes to the healthcare ecosystem  
Usability  
Implementation issues  
Clinical and administrative efficiency  
Security  
Access & transfer to information  
Regulations, standards and policies  
Implementation issues  
Workflows  
Workflow impact  
Complexity of care  
Skills and characteristics  
Patients & users  
User attitude toward information  
Computer anxiety  
Interoperability  
Face-to-face interaction versus new ways of working  
Trust & liability  
Accountability to employer & policy makers  
Interoperability  
Information & decision processes  
Regulations, standards and policies  
Lack of legal framework  
Perceived changes to the healthcare ecosystem  
Effects on healthcare tasks  
Confidence and accountability  
Usability  
Effects on healthcare tasks  
Interoperability  
Addressing organizational issues  
Roles, responsibilities & training  
Resourcing  
Addressing organizational issues  
Skills and characteristics  
Cognitive participation  
Perceived benefits and incentives  
Incentives  
Incentive  
Perceived changes to the healthcare ecosystem  
Usability  
Confidence and accountability  
Reflexive monitoring  
Motivation to use EHR  
Privacy & security concerns  
Usability  
Perceived ease of use  
Interoperability infrastructure |
| Kruse et al. [59]       | Systematic review          | Internal organizational and external factors associated with adoption of HIT | No restriction on healthcare setting or participants identified | 17      | 1993-2013 English | Governance, leadership and culture  
Competitiveness  
Location & size  
Interdependence  
Ownership  
Strategic alliances  
Communication among users  
Governess, leadership and culture  
Hierarchy  
Teamwork & cooperation  
Centre of gravity and autonomy  
Training  
Training, IT/HIT skills  
Support  
Workflows  
Physician arrangements  
Teaching status  
Support  
Technical & expert unity of effort  
Resourcing  
Payers  
Capital expenditure  
Changes in work processes & routines  
Skills and characteristics  
Training, IT/HIT skills  
Perceived benefits and incentives  
Incentives  
Incentive  
Perceived changes to the healthcare ecosystem  
Autonomy  
Addressing organizational issues  
Roles, responsibilities & training  
Resourcing  
Addressing organizational issues  
Skills and characteristics  
Cognitive participation  
Perceived benefits and incentives  
Incentives  
Incentive  |
| Lluch [19]              | Literature review          | Organisational barriers to HIT implementation | OECD and EFTA countries | 79      | 2007-2010 English | Governance, leadership and culture  
Hierarchy  
Teamwork & cooperation  
Centre of gravity and autonomy  
Training  
Training, IT/HIT skills  
Support  
Workflows  
Physician arrangements  
Teaching status  
Support  
Technical & expert unity of effort  
Resourcing  
Payers  
Capital expenditure  
Changes in work processes & routines  
Skills and characteristics  
Training, IT/HIT skills  
Perceived benefits and incentives  
Incentives  
Incentive  |
| Mair et al. [60]        | Explanatory systematic review of reviews | Factors that promote or inhibit e-health technology implementation | No restriction on healthcare setting or participants identified | 37      | Literature reviews 1990-2009 | Governance, leadership and culture  
Coherence  
Cognitive participation  
Addressing organizational issues  
Reflexive monitoring  
End-user involvement  
Cognitive participation  
Training  
Roles, responsibilities & training  
Support  
Perceived changes to the healthcare ecosystem  
Usability  
Confidence and accountability  
Privacy & security concerns  
Usability  
Perceived ease of use  
Interoperability infrastructure |
| McGinn et al. [49]      | Systematic review          | EHR implementation barriers and facilitators | Physicians, HCPs, pharmacists, admin, midwives, social workers, patients in health services comparable to Canada | 60      | 1999-2009 Empirical | Resourcing  
Lack of time & workload  
Cost issues  
Skills and characteristics  
Familiarity & |

(continued on next page)
| Author          | Design               | Focus                                | Setting/participants                                                                 | Studies | Inclusion criteria | Identified factors                                                                 |
|-----------------|----------------------|--------------------------------------|--------------------------------------------------------------------------------------|---------|--------------------|-----------------------------------------------------------------------------------|
| Nguyen et al. [7] | Systematic review   | EHR impact and issues                | Clinicians, patients, doctors, nurses, management, organizations & IT staff across primary, secondary, LTC, ambulatory & community care | 98      | 2003-2011          | Patient & health professional interaction Design or technical concerns Workflows Changes to workflow Skills and attitudes Perceived benefits and incentives Organization Adoption rate Implementation Systems development End-user involvement Systems development Implementation Training Service quality Implementation Support Service quality Implementation Resourceing Implementation Organizational change to the healthcare ecosystem Perceived benefits and incentives Governance, leadership and culture Organizational adoption rate Systems development End-user involvement Systems development Implementation Training Service quality Implementation Support Service quality Implementation Resourceing Implementation Organizational change to the healthcare ecosystem Perceived benefits and incentives Governance, leadership and culture Organisation Adoption rate Implementation Training Service quality Implementation Support Service quality Implementation Resourceing Implementation Organizational change to the healthcare ecosystem Perceived benefits and incentives Governance, leadership and culture Champion Openness of the organization to change & innovation Collaboration with vendors End-user involvement End-user participation Collaboration among administration, IT & clinical functions Use & user satisfaction Skills and characteristics People Perceived benefits and incentives Net benefits in terms of care quality, productivity & access Funding & incentives Perceived changes to the healthcare ecosystem Use & user satisfaction |
| Nguyen et al. [7] | Literature review    | Organisational success factors for HIT | No restriction on healthcare setting or participants identified                          | 36      | English            | Governance, leadership and culture Champion Openness of the organization to change & innovation Collaboration with vendors End-user involvement End-user participation Collaboration among administration, IT & clinical functions Use & user satisfaction Skills and characteristics People Perceived benefits and incentives Net benefits in terms of care quality, productivity & access Funding & incentives Perceived changes to the healthcare ecosystem Use & user satisfaction |
| O'Donnell et al. [13] | Systematic review and evidence synthesis | EMR adoption                         | Physicians in primary care                                                            | 33      | 1996-2017          | Use & user satisfaction Skills and characteristics People Perceived benefits and incentives Net benefits in terms of care quality, productivity & access Funding & incentives Perceived changes to the healthcare ecosystem Use & user satisfaction |

(continued on next page)
| Author et al. | Design | Focus | Setting/ participants | Studies | Inclusion criteria | Identified factors |
|--------------|--------|-------|-----------------------|---------|-------------------|--------------------|
| Police et al. [45] | Systematic review | Benefits and barriers to HIT implementation | Physicians in primary care | | | Governance, leadership and culture, Practice-based predictors & barriers, External policies & organizational barriers, Impact of practice culture, Training Educational barriers, Governance, leadership and culture, Governance & consensus building, End-user involvement Governance & consensus building, Training Support, Governance, leadership and culture, Implementation climate, Planning, Engaging, Reflecting & evaluating, Leadership engagement, Champions, Support End-user involvement Key stakeholders, Support, Governance, leadership and culture, Implementation climate, Planning, Engaging, Reflecting & evaluating, Leadership engagement, Champions, Support End-user involvement Key stakeholders, Support Governance, leadership and culture, Structural/ contextual/ organizational factors, Technical factors, Training Human factors, Support Structural/ contextual/ organizational factors | Resourcing Cost, Available resources, Workflows, Compatibility, Skills and characteristics, Knowledge & beliefs, Other personal attributes, Perceived benefits and incentives, Incentives, Reflecting and evaluating, Perceived changes to the healthcare ecosystem, Human factors, Workflows, Human factors, Skills and characteristics, Human factors, Perceived benefits and incentives, Technical factors, Perceived changes to the healthcare ecosystem, Human Factors, Usability | Interoperability, Technical factors, Usability, Interoperability, Technical factors, Infrastructure, Technical factors, Adaptability, Technical factors, Testing, Technical factors |
| Ratwani et al. [37] | Systematic review | EHR safety and usability challenges | No restriction on healthcare setting or participants identified | 55 | 2010-2016 English Peer-reviewed | | | |
| Ross et al. [62] | Umbrella review | Implementation of e-health | No restriction on healthcare setting or participants identified | 44 | 2009-2014 | | | |
| Sligo et al. [10] | Literature review with a meta-narrative | Large scale HIT planning, implementation and evaluation | No restriction on healthcare setting or participants identified | 382 | n/a | | | |
| Strudwick and Eyasu [47] | Literature review | Experiences with EHR implementation | Nurses in mental health settings | 7 | English | | | |
reviews, reports, books and guidelines identified. Perspectives of a variety of stakeholders were captured in these reviews including GPs (or primary care physicians), other doctors, nurses, health and social care professionals (HCPs), patients, policymakers, vendors and IT consultants (Table 3). Although many literature reviews encompassed studies from a variety of healthcare settings, others were specific to primary care (i.e., community) [13,44,45], long term care [46] and mental health settings [47] or within specific countries or groups of countries [19,48–51].

3.2. Synthesized findings

Fifteen common factors were identified and classified as organizational, human and technological. Each of these factors are discussed in detail below as well as how they interact within different contexts.

3.2.1. Organizational factors

Factors relating to the processes by which the EHR was introduced and incorporated into routine care were categorized as organizational [54]. Whilst each of the six factors were important across all contexts, the size and type of organization impacted on how each triggered success during the EHR implementation [46,53,61].

3.2.1.1. Governance, leadership and culture. The governance of the EHR implementation [13,19,37], as well as leaders [7,10,36,44,48,52–54,62,63] and organizational culture, were identified as paramount in enabling a successful EHR system [7,10,13,36,45–50,53,56,59,62]. Whilst top-down, middle-out and bottom-up governance structures have been utilised, ongoing political willingness, national policies and some independence at an individual organizational level regarding EHR procurement, development and design, were recommended to promote engagement, usability and interoperability [13,48,51,62]. It was also important that executive leaders such as GIs and project management teams established good and trusting relationships with vendors and consulting firms [12,44,52,56,63], and designed the implementation strategy with clear measurable objectives [10,50,52], a fitting implementation process (e.g., big-bang or phased) [44,46,51,58], and clear roles and divisions of labour [10,60]. A shift away from the dominance of top and middle management has also been recommended [10,19,36], with the appointment of local leaders or champions, and supporting of internal and external communication and collaboration [10,11,19,52,59], innovation and continual improvement [52], and patient-centred care [19]. This also helps to create a favourable [10,36,44,63] and flexible [52] culture.

3.2.1.2. End-user involvement. During each stage of the EHR implementation process, end-user involvement was highlighted as important [7,10,37,47,48,52,54,56,57,60,62,63], as it helps to ensure that the EHR meets end-users’ needs and workflows, as well as promoting a sense of ownership [37] and acceptance amongst staff [10,37,53]. Engaging end-users from each stakeholder group was recommended [36], and this has often been done in the form of appointing champions. These leaders should be respected amongst their colleagues as well as having the relevant knowledge to act as a bridge between the end-users and IT staff [60,62,63]. However, champions may sometimes need to be shared between organizations [10].

3.2.1.3. Training. Basic computer and EHR-specific training were identified as key to a successful EHR implementation [7,10,12,13,19,36,37,45,46,48–50,53,56,57,60,61,63]. However, the effectiveness and resource-efficiency of training depended on the appropriateness of the appointed trainers, training content, timing of training (i.e., as close to Go Live as possible [36]) and methods of training e.g., classroom based versus eLearning [57]. EHR training was also recommended on an ongoing basis for new staff, as well as existing staff to optimize their use of the system [37,53].

3.2.1.4. Support. Expert, technical, executive and external support have been critical to successful EHR implementations [7,10–13,19,36,37,44,50–53,56–58,60–63]. Expert or peer support, often referred to as super-users, reportedly helped end-users to optimize their use of the EHR [7,11,12,36,53], whereas technical support staff helped solve IT issues [51,62]. During Go Live (often first 3–4 weeks [37]), technical and peer support should be available 24/7 seven days a week in hospitals [12,36]. However, this may not be feasible or required in primary care centres but channels to obtain support during working hours remain important. Other crucial support comes from an executive or policy level [19,50–52,53,56,57,60,63] and professional networks or external parties [19,53]. Although maintenance support for servers and networks was not as evidenced in the identified literature [50], the expert panel also deemed this as important.

3.2.1.5. Resourcing. The availability of resources in terms of finance, skilled workforce and time was also important [7,10,12,13,36,37,44–46,48,49,51–54,56,59–63]. Financial resourcing was often highlighted as a barrier especially by primary care doctors [12,13] and those in lower income countries [48], and scope creep of the budget was a common occurrence for larger hospitals [10,52,54]. Therefore, a cost analysis which encompasses infrastructure, personnel, maintenance and ongoing optimization was critical [36,62]. Having a skilled workforce in-house who understand the clinical workflows was also recommended [53,61] as it can reduce dependence on and cost of vendors [12,36]. However, this may not be feasible for smaller organizations, and larger organizations also reportedly had issues with IT staff retention [10,13,36,48,51]. Adequate time for end-user involvement and habituation to the EHR was also vital [7,10,12] to ensure organizational readiness [7,13,51,53].

3.2.1.6. Workflows. Inability of the EHR system to meet the workflows of end-users and organizations was commonly cited as negatively impacting on success [7,10–12,36,37,51,52,54,56,62,63], including end-user efficiency, productivity, satisfaction and acceptance of the EHR [7,11,63]. Although replicating existing paper-based practices may minimize disruptions for end-users [7,13,19,62], re-engineering of workflows during digitization to make them safer and more efficient was recommended [19,62,63].

3.2.2. Human factors

Ability of healthcare organizations to successfully adopt an EHR system was largely determined by the individual end-users [10,54], and three overarching human factors were identified.

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**Table 3 (continued)**

| Author (Year) | Design | Focus | Setting/participants | Studies | Inclusion criteria | Identified factors | interest in computers/eco-system |
|---------------|--------|-------|----------------------|---------|-------------------|-------------------|-----------------------------------|
| O. Fennelly et al. |        |       |                      |         |                   |                   |                                   |

**Note:** EHR, Electronic health record; LTC, long-term care; HIT, Health Information Technology; OECD, Organisation for Economic Co-operation and Development; EFTA, European Free Trade Association; HCPs, Health and Social Care Professionals.
3.2.2.1. Skills and characteristics. IT skills as well as personal characteristics of individuals impacted on the success of an EHR implementation [10,12,50,51,53,56,58,60,62,13,19,36,37,44,47–49]. Assessing computer literacy of end-users enabled provision of basic computer training to those requiring it, prior to effective EHR training [36,48]. Whilst the research assessing the impact of age, gender and clinical experience on acceptance of the EHR reported in the identified reviews was inconclusive, personal traits such as being open-to-change and a problem-solver appeared to contribute to success [56,62]. However, resistance to embracing the EHR could also be attributed to non-usable technology [10,51].

3.2.2.2. Perceived benefits and incentives. Where individual end-users perceived the EHR to positively impact on patient care and workload, this reportedly facilitated a successful implementation [10,12,50,51,56,58,60,13,19,36,37,44,47–49]. However, realistic benefits and timeframes specific to the organization should be communicated with end-users [44,45,62]. Monetary incentives or penalties have also been shown to be important, especially for privately-governed organizations [13,45,59].

3.2.2.3. Perceived changes to the healthcare ecosystem. End-users’ concerns with changes to data privacy and security, patient-clinician relationships and their roles and responsibilities, appeared to negatively impact on EHR implementations [7,10,51,53,56,58,60–62,12,13,19,36,44,47–49]. These concerns may differ depending on the specific setting and type of sensitive personal information being collected (e.g., mental health) [47]. Therefore, specific concerns and their causes of concerns should be identified and addressed as soon as possible to mitigate their impact on EHR implementations [19,36].

3.2.3. Technological factors
Six factors relating to the technology aspect of the EHR implementation were identified as critical to its success and were intrinsically linked to the organizational and human factors.

3.2.3.1. Usability. EHR usability was deemed important across several reviews [7,10,11,13,36,37,44,46,47,49,51,52,54,58,60,62], as it impacted on end-user efficiency, patient-facing time [12,13,37,53], quality of care [12], patient-clinician relationships [52] and safety [37]. However, a simple and intuitive system in one setting may not be transferrable to another, and therefore, end-user involvement in development, design [10,37,62] and usability testing were recommended at each site [37]. Additionally, enabling personalization of the EHR interface [53] and access to legacy paper-based records [50,51] as well as consideration of data quality and accuracy [13,44,51] with use of health terminologies and classifications [56] was recommended. However, usability needs to be balanced with security [44].

3.2.3.2. Interoperability. To enable health information exchange both within and across healthcare organizations, interoperability was identified as critical [7,10,13,19,37,44,45,49–52,54,58,60,62]. Local contextual factors within countries such as two-tier and fully private health systems, lack of employment of national standards [45,53,62], inconsistent data capture in incompatible formats [12], have rendered the creation of a fully interoperable EHR as difficult. Therefore, technical standards and communication between organizations were recommended to ensure interoperability was built in from the outset including for legacy and existing health IT systems [7].

3.2.3.3. Infrastructure. Procurement or enhancement of infrastructure, including software (e.g., EHR, anti-viral), hardware (e.g., data-entry devices, Wi-Fi, power outlets) and furniture, accounted for a large proportion of the financial resourcing and were deemed critical for the success of the overall EHR implementation [10,12,56,62,63,36,47–53]. The existing and new hardware and software must be compatible with the specific EHR product [45], reliable and functional [13,36,44,53,56], and enable sufficient accessibility to the EHR for end-users [36,45,52,56]. According to the expert panel and additional literature reviewed, selection of mobile and stationary data-entry devices also require consideration of vendor certification, healthcare setting (e.g., outpatient rooms versus isolation rooms), required functions and workflows (e.g., checklists versus long narrative notes), and end-user preferences for usability.

3.2.3.4. Regulation, standards and policies. As stated earlier, national and international standards as well as regulation and policies were critical for interoperability and addressing privacy and security concerns [7,13,19,45,46,51,52,56,58,60,62,63]. Therefore, messaging and language standards [45,52,56], as well as robust privacy laws and policies [13,44,52,56,62] were recommended. Where healthcare organizations were permitted to procure their own EHR product, these standards would likely be especially important.

3.2.3.5. Adaptability. Many of the literature reviews reported that adaptability of the software was important to facilitate customization of the EHR software to meet the needs of the end-users and organizations [10,36,37,50,51,53,56,62]. This reportedly required the software vendors to be open to sharing code development data and willing to adapt their product [36,53], and the organization to have access to a skilled workforce with the capabilities to adapt the EHR to clinical workflows [37]. Where interoperability standards exist, the need for adaptations to the software may be reduced [37].

3.2.3.6. Testing. Comprehensive testing of the system was critical to ensure usability and safety [7,10,37,54], and was more commonly cited as important by IT staff and management than by HCPs [7]. This rigorous, resource-intensive, multi-step testing process of each EHR function needed to be conducted within live environments with actual end-users [54] and should not be underestimated.

4. Discussion
This umbrella review distilled the large volume of evidence available regarding the successful implementation of a national EHR and these findings were corroborated by an expert panel as being relevant to the Irish healthcare context. Fifteen key organizational, human and technological factors were identified as critical and by synthesizing the findings from several stakeholder groups and clinical settings, such as doctors in primary or secondary care [11,13,45,53,58,61] and nurses in a mental health setting [47], this review of reviews identified that each of these factors were also relevant and important to EHR and other HIT implementations across different healthcare contexts.

However, between country differences including health service management, politics, economics, regulation and socio-culture impact on how the identified factors influence success. This was evident in the literature reviews which largely focused on studies conducted in the predominantly private health service in the USA where return on investment and productivity were perceived benefits and incentives of EHRs or EMRs [50,51,56]. Additionally whilst the governance approach was identified as important, a successful approach in one country cannot necessarily be replicated in another, as occurred in the UK where the top-down approach successfully employed in the Netherlands resulted in disengaged healthcare organizations across the UK [22]. Therefore, these factors need to be employed with consideration of the national context and in the Republic of Ireland this will also require close collaboration and communication across the co-existing public and private health sectors [64,65], as well as with those in Northern Ireland (UK). Additionally, European Union (EU) citizens may avail of healthcare from any member state under the Cross-Border Healthcare...
Summary points

What was already known on the topic:

- Despite recognition of the huge potential for EHRs to improve the delivery of healthcare, huge challenges have been met in implementing a fully interoperable EHR across acute and community care.
- The implementation process of EHRs is critical to their success and needs to be carefully planned and considered across the complex and adapting healthcare landscape.
- A vast amount of literature exists on EHRs which has been relevant to specific stakeholder groups and healthcare contexts.

What this study adds:

- A comprehensive and clear overview of factors influencing the success of an EHR implementation across primary, secondary and long term care and different stakeholder groups is presented.
- Validation of these factors for the Irish healthcare context via co-production and transfer of knowledge with key knowledge-users.
- Generation of key considerations for each of these factors for policy-makers and other knowledge-users.

Despite recognition of the huge potential for EHRs to improve the delivery of healthcare, huge challenges have been met in implementing a fully interoperable EHR across acute and community care. The implementation process of EHRs is critical to their success and needs to be carefully planned and considered across the complex and adapting healthcare landscape. A vast amount of literature exists on EHRs which has been relevant to specific stakeholder groups and healthcare contexts.

4.1. Strengths and Limitations

Undertaking a rapid qualitative evidence synthesis requires acceleration of many of the research processes, is dependent on the reporting in the original reviews [32] and could risk losing the context and complexity of the original research setting [32,42,75]. Additionally, five of the literature reviews were conducted by the same lead author which could lead to bias of individual study inclusion. However, the inclusion of literature reviews, consideration of the inclusion criteria of each literature review and ongoing collaboration with an expert panel [30], provided a degree of confidence regarding the coherence, relevance and adequacy of the findings and their generalisability across healthcare settings [76]. Additionally, actively involving knowledge-users who were undertaking HIT implementations led to the concurrent translation of this knowledge into practice [77].

5. Conclusion

The key organizational, human and technological factors identified in this review provide policy-makers and other key stakeholders with a foundation for making evidence-based decisions during the implementation of a fully interoperable EHR across primary, secondary and long-term care. However, consideration of the specific contextual influences is critical to the successful application of these factors. Additionally, the end-users, existing technological standards and policies, and advances in technology and research in the area, will impact on how these factors dynamically interact during the EHR implementation and will influence success.

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Declaration of Competing Interest

The authors report no declarations of interest.

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Appendix A. Search Strategy

**Electronic Health record**
- Electronic health record*
- Electronic Healthcare Record*
- Electronic patient record*
- Computerized health record*
- Electronic medical record*
- Online health record*
- Digital health record*
- Computerized medical record*
- Electronic Medical Record
- Automated medical records
- Electronic health record
- Electronic health records
- Electronic medical record
- Computerized medical records
- Electronic Record System*
- Clinical Information system*
- Electronic Health Record System*
- Medical Information System
- Computerized medical systems
- Clinical data repository*
- Health Records System*
- Medical Records System*
- Health information system*
- Hospital information system*
- Health Information System
- Medical records system,
  Computerized
- Electronic health record system
- Medical information system
electronic prescribing
e-prescri*
  eprescri*
- Electronic pharmaceutical record
- Electronic Order Entry
  computerized ordering
- Medical Order Entry System*
- Drug Information System
- Order comm*
- Computerized Physician Order Management
- Computerized Provider Order Entry
- Computerized Provider Order Management
- Computerized Physician Order Entry
- Medical Order Entry Systems
- Electronic Order Entry
  Computerized provider order entry
- Personal health record*
- Patient health record*
- Electronic patient record*
- Patient portal*
- Shared care record*
- Summary care record*
- Patient data repository*
- Interoperability
- Health Care Information Exchange*
- Medical record linkage*
- Health Information Exchange
  Patient Portals
- Health Information Interoperability
  Data interoperability
- Interoperability
- Health Information Exchange
  Medical Record Linkage EHR
  PHR
  EHR

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