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

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Highlights
• Implementation process of Electronic Health Records (EHRs) is critical for success.
• Vast literature available on EHR implementations in different settings and contexts.
• Organizational, Human and Technological factors influence success across settings.
• Dynamic interaction of the identified factors trigger success.
• Consideration of the specific healthcare context and end-users is important.

Abstract

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.

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.

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.

**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 also 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.

**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.

**Key words**

Electronic Health Record; Electronic Medical Record; Implementation; Review.

1. Introduction

Capturing and effectively using clinical information and knowledge to ensure a quality, safe and sustainable healthcare service is widely recognised and data from electronic health records (EHRs) have been vital to decision-making on public health policies during the COVID-19 pandemic. 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. As well as expanding the capacity to utilise clinical data for monitoring of patient outcomes and conducting audits and research, the EHR provides access to patient information in a timely manner, enabling healthcare professionals (HCPs) to spend more time with patients, reducing duplication of tests and work, and improving the safety and quality of care. Additionally, integration of other functions and software, such as clinical decision support and bar code medication administration, further expand its potential benefits.

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. 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, often attributed to the implementation process as opposed to the product supplied by the EHR vendor. Therefore, the implementation process is critical 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 primary 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; 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.

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 \(^{30}\) 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 informatics 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.

| 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. |
| Clinical Health and Social Care Professional Lead in the Clinical Management System, National Rehabilitation Hospital. |
| Associate Professor in Physiotherapy, UCD. |
| Business Manager, National MN-CMS Project Team. |
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 \(^4\). Having reached a final consensus regarding the factors for a successful EHR implementation, these factors were further categorized into a theoretical framework \(^1\) and resulted in the generation of key considerations \(^4\).

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, 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, 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 \(^19,48–51\).
Figure 1. PRISMA Flow Diagram
<table>
<thead>
<tr>
<th>Author (Year)</th>
<th>Design</th>
<th>Focus</th>
<th>Setting participants</th>
<th>Studies</th>
<th>Inclusion criteria</th>
<th>Identified factors</th>
<th>Identified factors</th>
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<th>Interoperability</th>
<th>Inadequate data exchange</th>
<th>Interinstitutional integration</th>
<th>Infrastructure</th>
<th>Interoperability</th>
<th>Reliability, speed &amp; wireless connectivity</th>
<th>Physical space</th>
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<td>Ajami and Bagheri-Tadi (2013)</td>
<td>Non-systematic review</td>
<td>Barriers to EHR adoption</td>
<td>Physicians in hospital or community</td>
<td>20</td>
<td>n/a</td>
<td>Governance, leadership and culture</td>
<td>Skills and characteristics</td>
<td>Computer literacy &amp; skill</td>
<td>Ability to select &amp; effectively install system</td>
<td>Perceived benefits and incentives</td>
<td>Lack of incentives</td>
<td>Perceived changes to the health ecosystem</td>
<td>Interactions with doctor-patient relationship</td>
<td>Interfaces with doctor-patient relationship</td>
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<td>Boonstra et al., (2014)</td>
<td>Systematic review</td>
<td>EHR implementation lessons</td>
<td>Project team, doctors, nurses, technical &amp; clerical personnel, IT personnel, psychiatrists, directors, CEOs, CIOs, managers, vendors, healthcare practitioners, pharmacists, in hospitals</td>
<td>21</td>
<td>Up until 2013 English, Peer-reviewed Empirical</td>
<td>Governance, leadership and culture</td>
<td>Support</td>
<td>Real-time support</td>
<td>Management support</td>
<td>Resourcing</td>
<td>Financial capabilities</td>
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<td>Barriers to acceptance of EMRs</td>
<td>Physicians in any healthcare organisations</td>
<td>22</td>
<td>1998-2009</td>
<td>Governance, leadership and culture</td>
<td>Support</td>
<td>Start-up &amp; ongoing costs</td>
<td>Time to select, learn &amp; convert patient records</td>
<td>Skills and characteristics</td>
<td>Lack of computer skills</td>
<td>Need for control</td>
<td>Perceived benefits and incentives</td>
<td>Return on investment</td>
<td>More time per patient</td>
<td>Lack of belief in EMRs</td>
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Table 3 continued
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<th>Reference</th>
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<th>Barriers to and Adoption</th>
<th>Supporting Factors</th>
<th>Key Findings</th>
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<td>Empirical Design Link with primary care</td>
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<td>English Until July 2016</td>
<td>Governance, leadership and culture</td>
<td>Increase of nurses &amp; physician’s workload</td>
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Table 3 continued
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<th>Year(s)</th>
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<td>Systematic review and evidence synthesis</td>
<td>Physicians in Primary care</td>
<td>33</td>
<td>1996-2017</td>
<td>Governance, leadership and culture Organization Implementation Training Support</td>
<td>Use &amp; user satisfaction Skills and characteristics People Perceived benefits and incentives Net benefits in terms of care quality, productivity &amp; access Funding &amp; incentives Perceived changes to the healthcare ecosystem</td>
<td>Usability Quality of information, system &amp; service Interoperability Quality of information, system &amp; service Infrastructure Quality of information, system &amp; service Regulations, standards and policies Legislation, policy &amp; governance</td>
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<td>Systematic review</td>
<td>Physicians in Primary care</td>
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<td>2004-2009</td>
<td>Governance, leadership and culture Practice-based predictors &amp; barriers External policies &amp; organizational barriers Impact of practice culture Educational barriers</td>
<td>Resourcing Financial barriers Perceived benefits and incentives Staff-related barriers Perceived changes to the healthcare ecosystem Technological barriers</td>
<td>Interoperability Technological barriers Infrastructure Technological barriers Regulations, standards and policies External policies &amp; organizational barriers Technological barriers</td>
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<td>2010-2016</td>
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<td>Resourcing Cost and resources Workflows Clinical workflow Skills and characteristics Training</td>
<td>Customization Usability testing Adaptability Customization Testing Risk assessment Usability testing</td>
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<td>Ross et al. (2016)</td>
<td>Umbrella review</td>
<td>Any</td>
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<td>2009-2014</td>
<td>Governance, leadership and culture Implementation climate Planning Engaging Reflecting and evaluating Leadership engagement Champions End-user involvement Key stakeholders Support Training</td>
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<td>Perceived changes to the healthcare ecosystem Knowledge &amp; beliefs Usability Complexity Interoperability Infrastructure Complexity Regulations, standards and policies External policy Adaptability</td>
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<td>End-user involvement Skills and characteristics Characteristics of nurses Experience and interest in computers</td>
<td>Perceived benefits and incentives Perceived changes to the healthcare ecosystem</td>
<td>Usability Infrastructure Physical space Lack of computers</td>
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Note: EHR, Electronic health record; LTC, long-term care; HIT, Health Information Technology; OECD, Organisation for Economic Co-operation and Development; EFTE, European Free Trade Association.
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.

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 ensuring 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 CIOs and project management teams establish 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 helps create a favourable 10,36,44,63 and flexible 52 culture.

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 10,37,63. 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.

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.

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. During Go Live (often first 3–4 weeks), technical and peer support should be available 24/7 seven days a week in hospitals. 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 and professional networks or external parties. Although maintenance support for servers and networks was not evidenced in the identified literature, the expert panel also deemed this as important.

**Resourcing**
The availability of resources in terms of finance, skilled workforce and time was also important. Financial resourcing was often highlighted as a barrier especially by primary care doctors and those in lower income countries, and scope creep of the budget was a common occurrence for larger hospitals. Therefore, a cost analysis which encompasses infrastructure, personnel, maintenance and ongoing optimization was critical. Having a skilled workforce in-house who understand the clinical workflows was also recommended as it can reduce dependence on and cost of vendors. However, this may not be feasible for smaller organizations, and larger organizations also reportedly had issues with IT staff retention. Adequate time for end-user involvement and habituation to the EHR was also vital to ensure organizational readiness.

**Workflows**
Inability of the EHR system to meet the workflows of end-users and organizations was commonly cited as negatively impacting on success, including end-user efficiency, productivity, satisfaction and acceptance of the EHR. Although replicating existing paper-based practices may minimize disruptions for end-users, re-engineering of workflows during digitization to make them safer and more efficient was recommended.

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

**Skills and characteristics**
IT skills as well as personal characteristics of individuals impacted on the success of an EHR implementation. Assessing computer literacy of end-users enabled provision of basic computer training to those requiring it, prior to effective EHR training. 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. However, resistance to the EHR could also be attributed to unusable technology.

**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. However, realistic benefits and timeframes specific to the organization should be communicated with end-users. Monetary incentives or penalties have also been shown to be important, especially for privately-governed organizations.
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. These concerns may differ depending on the specific setting and type of sensitive personal information being collected (e.g., mental health). Therefore, specific concerns and their causes of concerns should be identified and addressed as soon as possible to mitigate their impact on EHR implementations.

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.

Usability
EHR usability was deemed important across several reviews, as it impacted on end-user efficiency, patient-facing time, quality of care, patient-clinician relationships and safety. However, a simple and intuitive system in one setting may not be transferrable to another, and therefore, end-user involvement in development, design and usability testing were recommended at each site. Additionally, enabling personalization of the EHR interface and access to legacy paper-based records was recommended. However, usability needs to be balanced with security.

Interoperability
To enable health information exchange both within and across healthcare organizations, interoperability was identified as critical. Local contextual factors within countries such as two tier and fully private health systems, lack of employment of national standards, inconsistent data capture in incompatible formats, 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.

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. The existing and new hardware and software must be compatible with the specific EHR product, reliable and functional, and enable sufficient accessibility to the EHR for end-users. 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., outpatients versus isolation rooms), required functions and workflows (e.g., checklists versus long narrative notes), and end-user preferences for usability.

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. Therefore, messaging and language standards, as well as robust privacy laws and policies were recommended. Where healthcare organizations were permitted to procure their own EHR product, these standards would likely be especially
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. This reportedly required the software vendors to be open to sharing code development data and willing to adapt their product, and the organization to have access to a skilled workforce with the capabilities to adapt the EHR to clinical workflows. Where interoperability standards exist, the need for adaptations to the software may be reduced.

Testing
Comprehensive testing of the system was critical to ensure usability and safety, and was more commonly cited as important by IT staff and management than HCPs. This rigorous, resource-intensive, multi-step testing process of each EHR function needed to be conducted within live environments with actual end-users 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.十五 key organizational, human and technological factors were identified as critical and by synthesizing the findings from several different stakeholder groups and clinical settings, such as doctors in primary or secondary care and nurses in a mental health setting, this review of reviews identified that each of these factors were also relevant and important to EHR implementations across different healthcare settings.

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 largely private health service in the USA where return on investment and productivity were important perceived benefits and incentives. 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 in the UK. 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, as well as with Northern Ireland (UK). Additionally, European Union (EU) citizens may avail of healthcare from any members state under the Cross-Border Healthcare Directive (2011/24/EU) and thus, efficient exchange of health data across borders is a major priority and is a pillar of EU4Health 2021-2027. Therefore, the EU interoperability policies and frameworks as well as standards such as the International Patient Summary, the General Data Protection Regulation (GDPR) and standardised terminologies to support these frameworks need to be employed.

Despite the expansion in internationally-recognised standards (e.g., HL7 FHIR) and significant regulatory and financial incentives created by the HITECH Act and “Meaningful Use” requirements in the USA, factors such as Usability and Regulations, standards and policies
continue to be highlighted as important for success as opposed to being assumed components of EHR products. Whilst the inclusion of older studies by these reviews is perhaps attributable, it is also likely that standards and requirements alone will not ensure an interoperable and usable EHR. In fact, it is the dynamic interaction between each of the identified factors which promote a successful EHR. However, more emphasis placed on an individual factor can reduce the resources required for others, for example promoting Usability and Standards can respectively reduce the burden of training and support, and adaptability. Additionally, this may be achieved by advances in evidence and technology such as artificial intelligence (AI) including automated testing, eLearning modules, and personalization of the EHR interface. Therefore, it is recommended that those involved in each aspect of the implementation process communicate throughout if and review the latest evidence regarding technology including peer-reviewed publications and white papers.

At a more local or meso level, the size of the organization, infrastructure, organizational readiness and culture, capabilities and beliefs of the workforce, and available finance, were also identified as important when considering the application of the identified factors. Certain aspects of the internal context can be enhanced to improve the likelihood of EHR success such as employing change management to create a clear and realistic vision of the EHR and providing basic computer training. However, the size of the organization and its workforce will likely remain more limited compared to their larger counterparts. Therefore, sharing of resources such as champions, support staff and trainers between larger and smaller hospitals or primary care settings has been recommended, with some countries creating networks or encouraging collaboration between existing regional groups of healthcare organizations.

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 and could risk losing the context and complexity of the original research setting. 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 provided a degree of confidence regarding the coherence, relevance and adequacy of the findings and their generalisability across healthcare settings. Additionally, actively involving knowledge-users who were undertaking HIT implementations led to the concurrent translation of this knowledge into practice.

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, critical to the application of these factors within an implementation process also requires consideration of the specific contextual influences. 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 EHR implementation and will influence success.

Summary points

What was already known on the topic:
• Despite recognition of the huge potential for EHRs to improve the delivery of healthcare, no country has successfully implemented 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.

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This work was supported by the Office of the Nursing and Midwifery Services Director, Health Service Executive (HSE), Ireland.

Declarations of interest
None

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Medical Records System
Health information system
Hospital information system
Health Information Systems
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Electronic health record system
Medical information system
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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
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EHCR
EPR
EMR
CIS
EHRS
DIS
CPOM
CPOE
EPR
EHRS
HIE

**Implementation**
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Introduce*
Adopt*
Develop*
Establish*
Process*
Execute*
Employ*
Instigate*
Launch*
Re-launch
Commence*
Initiate*
Uptake*
Configuration*
Customization*
Re-optimize*
Optimise*
Rollout*
Evaluate*
Assess*
Design
Facilitate*
Barrier*
Challenge*
Benefit*
Success
Failure

**Systems Development**
**Systems Implementation**

**Literature Review**
Systematic Review
Scoping Review
Meta Analysis
Literature review
Systematic review
Scoping review
Meta-analysis
Meta-synthesis
Systematic interpretive review
Systematic methodological review
Systematic meta-review
Systematic literature review
Qualitative synthesis

Note: *, truncation; ?, wildcard; italicised terms, refer to subject headings which were exploded in the relevant databases.

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