AUSTRALIAN COMMISSION
ON SAFETY AND QUALITY IN HEALTH CARE

December 2017

Implementation Method and Clinical Benefits of Using National Electronic Health Records in Australian Emergency Departments

Literature review and environmental scan for the My Health Record in Emergency Departments project

Published by the Australian Commission on Safety and Quality in Health Care
Level 5, 255 Elizabeth Street, Sydney NSW 2000

Phone: (02) 9126 3600
Fax: (02) 9126 3613

Email: mail@safetyandquality.gov.au
Website: www.safetyandquality.gov.au

ISBN: 978-1-925665-31-4

The Commission's preference is that you attribute this publication (and any material sourced from it) using the following citation:

> Australian Commission on Safety and Quality in Health Care. Implementation Method and Clinical Benefits of Using National Electronic Health Records in Australian Emergency Departments: Literature review and environmental scan for the My Health Record in Emergency Departments project. Sydney: ACSQHC; 2017

Disclaimer

The content of this document is published in good faith by the Australian Commission on Safety and Quality in Health Care for information purposes. The document is not intended to provide guidance on particular healthcare choices. You should contact your healthcare provider on particular healthcare choices.

The Commission does not accept any legal liability for any injury, loss or damage incurred by the use of, or reliance on, this document.

Contents

Figures

Tables

Key Definitions

Term	Definition
Clinical Information System (CIS)	The software used by the healthcare organisation that allows for entry and access of a patient's clinical information
Electronic Health Record (EHR)	An online electronic application or repository through which individuals can access, manage and share their health information, and that of others for whom they are authorised, in a private and secure environment. For the purposes of this literature review, the My Health Record is considered an EHR
Electronic Medical Record (EMR)	A clinical information system, internal to a healthcare organisation, which stores a patient's clinical information and is accessed by healthcare providers
My Health Record	Australia's national EHR, which is a summary of a consumer's health information that is sourced from a variety of providers across the healthcare system, and accessible by consumers and healthcare professionals

Executive Summary

This literature review provides background information to inform the implementation and use of the My Health Record in Australian emergency departments (EDs). The My Health Record is considered a national Electronic Health Record (EHR) system. EHRs are a summary of a consumer's health information that is sourced from a variety of healthcare providers. These providers can include general practitioners (GP), hospitals, specialists, and community pharmacists. EHRs are different to an Electronic Medical Record (EMR), with the latter being a system internal to a healthcare organisation, such as a hospital, and is only accessible by healthcare providers. The findings from this literature review seek to address two principle research questions:

- What are the benefits of using EHRs in hospital EDs?
- What barriers and enablers affect the routine use of EHRs by clinicians in hospital EDs?

The report provides:

- An overview of the current status of My Health Record implementation, including within EDs
- An overview of national EHR implementations in the UK, Denmark, Austria and Canada, describing key EHR features, implementation approaches and application to emergency care settings
- Literature findings in relation to the implementation of EHR in ED, including the demonstrated benefits, and the barriers and enablers for implementation.

Benefits are examined in relation to the domains of safety, quality, effectiveness of care, and efficiency. They are also examined from the point of view of patients, clinicians and organisations.

Barriers and enablers are identified at various levels, including in relation to:

- The attributes of the overall My Health Record system
- The content and interoperability of the record
- Clinician-related factors
- Patient-related factors
- Organisational factors.

There is a gap within the peer-reviewed literature regarding EHR patient-outcome measures. Many experts in the field suggest this reflects the absence of scientific frameworks in which EHR systems are implemented, although there are examples of some states and territories embracing a systematic approach to demonstrate the clinical value of their EHRs.

Limited information was found in the grey literature to demonstrate the benefits of EHR use in emergency care, although the anticipated benefits are well documented in various high-level strategies and plans for implementation.

The environmental scan demonstrated that international health jurisdictions varied in their EHR implementation. Consumer-centred access control featured prominently in EHRs of developed countries, highlighting that privacy remains a universal concern. EHR content focuses on patient demographics, treatment history, medications, allergies, and recent tests, mainly pathology and diagnostic imaging.

Table 1: Summary of barriers, benefits and patient outcomes of EHR use in ED

Domain	Barriers	Benefits	Patient Outcomes
Patient safety	• Poor training and awareness[17] • Poor system interface between EHR and EMR[13]	• Access to critical information in an emergency situation[40, 100] • Reduced duplication of diagnostic imaging[62] • Reduced duplication of pathology[8]	• Reduced inappropriate admissions[12,40] • Reduced adverse drug reactions[44] • Reduced radiation exposure[62]
Quality of care	• Lack of trust with content[87] • Poor accessibility[24]	• Improved and timely access to information for complex patients with multiple comorbidities[8] • Improved decision-making[12]	• More appropriate care[12]
Efficiency	• Poor integration with workflows[95] • Poor useability and navigation of content[9]	• Improved workflow[11, 42] • Improved sourcing and documenting of a patient's history[54]	• Improved communication[9]
Effectiveness	• Lack of content[88]	• Improved treatment plans[13, 15]	• Reduced readmissions[9, 12, 15]

In terms of barriers and enablers, studies[100, 103] have shown that ED clinicians' interactions with an EHR system are motivated by the availability of summary information, and by accessibility through integration with 'in-house' clinical information systems (CISs). Research has noted clinicians find this particularly useful for mostly complex patients with comorbidities.[12] Previous encounters, dispensed medications, pathology, and imaging results are closely associated with an ED clinician's decision to admit or discharge a patient.[15] Hospitalisations and readmissions are less likely if an ED clinician uses an EHR during their examination and treatment.[12]

The usability of EHRs within the ED setting is dependent on components of the EHR user interface, such as system functionality, document display, and access to content.[13] The adoption of EHR systems by ED clinicians is impeded by poor functionality and lack of integration with existing ED workflows.[49] This is exacerbated during busy periods, which are common in the time-poor environment of an ED.[103] Clinicians have a low tolerance of access delays to EHR content, generally being prepared to wait no more than three seconds.[87]

EHR use by ED clinicians, on a regular basis as part of routine clinical tasks, is positively associated with high rates of patient registration and clinical content.[17] EHR implementation should be supported with training, no less than two weeks prior to 'go-live'.[43] Investment in suitable infrastructure can provide assurance to clinicians regarding dependability and speed of access.[96] Lessons learnt from the international literature indicate adaptive changes must receive the same due diligence as technical changes. [50] The former point highlights the fact that users should be supported in adjustments to their work processes, which will assist in embedding and optimising routine EHR use.

1. Introduction

The My Health Record is a summary of a consumer's health information, sourced from a variety of providers across the healthcare system. The My Health Record is a national EHR that allows consumers and healthcare providers to securely access a consumer's health information to aid in clinical care. Introduced in 2012, the system aims to provide an additional source of information for clinical decision-making, to improve the care provided by healthcare providers to consumers.

By December 2017, more than 5.4 million people had a My Health Record and 10,600 healthcare organisations were registered with the system.[7] Ongoing expansion of the My Health Record system is a feature of the national health reform agenda to achieve greater agility and sustainability in the health system, and is central to Australia's National Digital Health Strategy (2018–2022).[5] The National Digital Health Strategy was prepared by the Australian Digital Health Agency (the Agency) and was approved by health ministers through the Council of Australian Governments (COAG) Health Council.

The National Digital Health Strategy identifies digitally-enabled models of care that can improve accessibility, quality, safety and efficiency. The National Digital Health Strategy outlines six 'test beds' that aim to improve patient outcomes using digital health technologies. Each test bed examines lessons learned from the implementation and roll-out of different digital health technologies across a variety of environments. The test beds will be evaluated to determine the integration of digital health technologies into existing clinical workflows and the benefits to patient care models. The My Health Record in Emergency Departments project is one of the test beds outlined in the National Digital Health Strategy.

The Agency appointed the Australian Commission on Safety and Quality in Health Care (the Commission) to undertake the My Health Record in Emergency Departments project. This project will examine how healthcare information can be shared across health and care practitioners in real-time, to better support management of healthcare emergencies.

The objective of the project is to develop a national model for routine use of the My Health Record system by clinicians in hospital EDs. To inform this project, and stakeholder engagement activities, a literature review and environmental scan has been conducted to assist in:

- Identifying factors that facilitate or limit the uptake and use of EHRs in the ED setting
- Determining safety and quality considerations for routine use of EHRs in the ED
- Strengthening the development of a pilot model for routine use of the My Health Record by clinicians in hospital EDs, by incorporating empirical data from scientific and grey literature.

This literature review describes the findings from the peer-reviewed and grey literature, and draws conclusions regarding the implications for the project. The findings will be used in stakeholder activities, such as workshops and interviews, throughout the project.

1.1 The roles of the Australian Digital Health Agency and the Australian Commission on Safety and Quality in Health Care

The Agency is tasked with improving health outcomes for all Australians through the delivery of digital healthcare systems and implementation of the National Digital Health Strategy for Australia. The Agency was established on 1 July 2016 by the Australian Government as a statutory authority and reports to all Australian governments through the COAG Health Council. The Agency assumed responsibilities as System Operator for the My Health Record system from the Australian Government Department of Health on 1 July 2016.

The role of the Commission is to lead and coordinate national improvements in the safety and quality of health care. The Commission works in partnership with the Australian Government, state and territory governments and the private sector to achieve a safe, high-quality and sustainable health system. In doing so, the Commission also works closely with patients, carers, clinicians, managers, policymakers and healthcare organisations.

1.2 The My Health Record in Emergency Departments Project

The Commission, on behalf of the Agency, is undertaking a project to develop and pilot a model to establish routine use of the My Health Record system by clinicians in hospital EDs. Routine use of the My Health Record by hospital ED clinicians is expected to improve utility for other healthcare providers and consumers.

The project is an extension of the Commission's clinical safety review program of the My Health Record. In September 2016, the Commission completed and submitted clinical safety review 7.1 *Assessing the Impact and Safety of the Use of the My Health Record System in Emergency Departments* to the Agency. The review analysed the extent of use of the My Health Record by clinicians in EDs and the impact and implications of clinician use.

The review found that jurisdictions have made progress in building the technical capability to upload and view information held in the My Health Record system in ED settings. Several public and private hospital ED are connected to the My Health Record system, but this has not translated into clinicians' routine processes, and use of this capability remains low.

Following receipt of clinical safety review 7.1, the Agency sought advice from the Commission to establish a project that would develop and pilot a model for increasing the adoption and use of the My Health Record system among ED clinicians.

ED clinicians often require information external to the hospital's CIS and medical records. The My Health Record can provide ED clinicians with supplementary information that may be applied to patient care. The My Health Record in ED project is potentially adaptable for use in other healthcare settings, as a number of the barriers and enablers of EHR use by ED clinicians are common to other healthcare providers.

The project model will be developed based on the My Health Record participation trials conducted in June 2016 by the Primary Health Networks (PHNs) of Nepean Blue Mountains and Northern Queensland. Within these PHNs are Local Health Districts (LHDs) or Hospital and Health Services (HHSs), which oversee several public hospitals and services within their organisations. The Commission will work with hospitals to develop the model over the course of the project. This model will then be piloted in other hospitals in Australia.

2. Background

2.1 Overview of Australia’s My Health Record

The Australian Digital Health Agency released the National Digital Health Strategy in August 2017. The strategy proposes seven strategic priority outcomes to be achieved by 2022.[5]

Figure 1: Strategic Priorities of the National Digital Health Strategy[5]

Vision

Better health for all Australians enabled by seamless, safe, secure digital health services and technologies that provide a range of innovative, easy to use tools for both patients and providers.

Key Themes

1. Support me in making the right healthcare choices, and provide me with options
2. Help all the people who care for me to understand me, and together, provide safe and personalised care
3. Create an environment where my healthcare providers and I can use and benefit from innovative technologies
4. Preserve my trust in the healthcare system and protect my rights

Strategic Priorities

1. Health information that is available whenever and wherever it is needed
2. Health information that can be exchanged securely
3. High-quality data with a commonly understood meaning that can be used with confidence
4. Better availability and access to prescriptions and medicines information
5. Digitally-enabled models of care that improve accessibility, quality, safety and efficiency
6. A workforce confidently using digital health technologies to deliver health and care
7. A thriving digital health industry delivering world class innovation

The My Health Record system is a feature of the National Digital Health Strategy and is comprised of information and communications technology (ICT) infrastructure that facilitates and supports the collection, use and disclosure of health records from many sources. Under the My Health Record system, a consumer’s health records are either uploaded into the National Repositories Service (NRS) or obtained from participating repositories. The NRS is the database system operated by the National Infrastructure Operator, which holds the datasets that make up a My Health Record. Individuals can access their My Health Record through the online consumer portal via the Australian Government’s ‘myGov’ website.

The My Health Record system has the following document types:

- Shared health summary
- Event summary
- Discharge summary
- Medication records

- eReferral
- Specialist letter
- Medicare records, including Pharmaceutical Benefits Scheme (PBS) and Medicare Benefits Schedule (MBS) items.

A shared health summary (SHS) is a clinically reviewed summary of an individual's health status at a point in time, authored by an individual's 'nominated healthcare provider', commonly their GP. The SHS may include information about a patient's medical history, including medications they are currently taking, allergies and adverse reactions they may have, or immunisations they have received. The uploading of an SHS is particularly relevant for patients with chronic conditions and comorbidities.

An event summary differs from an SHS in that it can be created by healthcare providers other than the individual's nominated healthcare provider (for example, pharmacist, ED physician or after-hours care provider) to record a significant health event. This would inform other treating healthcare providers, including the individual's nominated healthcare provider. An event summary includes details such as allergies and alerts, medications, diagnosis, interventions, diagnostic investigations and observations.[4]

Patients are also able to add information to their My Health Record including:

- Personal Health Summary
    - individuals can enter information about allergies and adverse reactions, and current medications into their My Health Record
    - this data can be viewed by healthcare providers
- Advance Care Directive Custodian
    - individuals can enter the contact information of a person or organisation who is the holder of their advance care directive (or 'living will')
- Emergency Contact Details
    - individuals can create a list of important emergency contacts in their My Health Record, which is visible to healthcare providers
- Personal Health Notes
    - individuals can enter information to help them keep track of their health
    - the system dates each note, which includes an entered title and the entered text
    - the notes are not visible to healthcare providers
- Child development
    - parents can record results of their child's scheduled health checks, childhood development and other useful information.

The objective of the My Health Record expansion program is that, by the end of 2018, every Australian will have a My Health Record, unless they choose to opt out. In addition, by 2022:

- All healthcare providers will be able to contribute to and use health information in My Health Record on behalf of their patients
- Patients and consumers will be able to access their health information at any time

online and through mobile apps

- My Health Record will be a platform for innovation in the provision of digital apps and tools that will support Australians and their health providers to improve health and wellbeing.[5]

2.2 Implementation status of My Health Record in Australian jurisdictions

Prior to the introduction of the My Health Record in 2012, many Australian states and territories were developing their own EHRs. The following is a brief summary of these jurisdiction-based EHRs that existed prior to the My Health Record and how these EHRs link with the My Health Record. Reference is made to the use in EDs where available.

2.2.1 Northern Territory

The Northern Territory's My eHealth Record has been in operation since 2004.[81] This system was designed principally to overcome fragmentation of clinical information by ensuring it could be quickly and easily accessed by participating healthcare providers.

During 2015, NT Health hospitals and health centres began transitioning from the My eHealth Record to the national My Health Record system. Information in My eHealth Record is still available to view; however, any new information is sent to a patient's national My Health Record, if they have one.

An evaluation of the My eHealth Record system was conducted in order to inform this transition.[68] The main findings related to: the value of the My eHealth Record system; the gradual evolution towards critical mass; and the success factors, including implications for the national My Health Record system.

Benefits attributable to the My eHealth Record service included:

- Increased access to consumers' health information
- Reduced time spent sourcing health information
- Supporting providers' clinical decision-making and patient safety
- Improved continuity of care
- Increased confidence for both consumers and providers
- Increased capacity to provide proactive population-based primary health care.

According to the evaluation, the My eHealth Record service was able to realise this value through a gradual evolution towards critical mass, which in turn depended on:

- Population registration – 50% consumer registration appears to be associated with the 'tipping point' at which the My eHealth Record service reached critical mass, and usage increased markedly
- Provider registration – there was a steady increase in provider registrations from the outset
- Sufficient record content – an increase was recorded in the number of documents sent by GPs before there was an increase in the number of documents viewed, implying the importance of having adequate content in the records.

Factors identified in the success of the system and considered relevant to successful implementation of the national My Health Record system included:

- Sustaining consumer and provider registration activities
- Stimulating content generation and utilisation across sectors
- Ensuring policy and technical frameworks remain flexible and are clearly communicated
- Ensuring clinical governance mechanisms are in place to capture consumer input and feedback
- Optimising CIS use to ensure high-quality data.

While not specifically referring to the use of My Health Record in ED, these factors are likely to be applicable to EHR implementation across all settings.

2.2.2 Queensland

In Queensland, all public hospitals and health services are connected to the My Health Record system (as of June 2016). This allows Queensland Health hospitals to send discharge summaries to a patient's My Health Record. In addition, all Queensland Health clinicians can view a patient's My Health Record through a specialised Queensland Health application called 'The Viewer'.[66] The Viewer is a web-based application that displays patient information from a number of Queensland Health clinical and administrative systems, such as pathology results, radiology results, medications, allergies and alerts, outpatient appointments, and care plans, as well as a record of encounters, including discharge summaries.

From June 2017, Queensland GPs have been able to access patient healthcare information from Queensland public hospitals via The Viewer. GPs are granted read-only access via a secure online portal, once their personal and professional identity is confirmed. If patients prefer their GP not to have access to their public healthcare information, they have the right to opt out.

2.2.3 South Australia

In 2013, South Australia introduced the Enterprise Patient Administration System (EPAS), an integrated electronic patient record system designed to provide a consistent and complete clinical and administrative EHR for patients across all South Australian public hospitals and health services.[90] The system has the capability to automatically send discharge summaries to a patient's My Health Record.

SA Ambulance staff also have immediate read-only access to the EPAS, allowing for more timely and appropriate treatment in an emergency.

2.2.4 New South Wales

The New South Wales EHR system is called HealtheNet, which was implemented in 2014 and provides a statewide view of a person's clinical history, including:

- Discharge summaries from NSW public hospitals
- Diagnostic imaging
- Hospital encounter history information from Emergency, Inpatients and Outpatients

departments
- Patient identifiers from NSW public hospitals and a patient's national Individual Healthcare Identifier (IHI)
- NSW Community Health Services episodes of care information
- Access to My Health Record Information.

The eHealth Strategy for NSW Health 2016–2026 guides continued development and strengthening of e-health solutions across the state.[83]

2.2.5 Australian Capital Territory

From March 2013, Canberra Hospital began submitting electronic discharge summaries to the national My Health Record.[1] In September 2013, the ACT became the first state or territory with the capability to access and view My Health Record information within existing local CISs.[1]

2.2.6 Victoria

In November 2016, the Victorian Minister for Health released a digital health technology strategy for Victoria, called *Digitising health – how information and communications technology will enable person-centred health and wellbeing within Victoria*.[104] Some individual hospitals have been developing interfaces between the hospital CIS and the My Health Record. Victoria is now systematically coordinating the connection of public hospitals to the My Health Record, with almost a quarter of public hospitals already connected. That program will rapidly expand in early 2018.

2.2.7 Tasmania

The Tasmanian Health Service currently has a major project under way that will integrate the My Health Record into the Digital Medical Record, which is the principal patient record system.

2.2.8 Western Australia

Information sharing and management, including secure sharing of patient information to improve patient safety, quality of care and care coordination, is one of the five priority areas identified in the WA Health ICT Strategy 2015–2018.[105] This includes plans to continue to work with the Australian Government and other states and territories on the integration of My Health Record with the WA Health system, but no further information about the progress of this was available.

Overall, EHR implementation in Australian states and territories is at various stages. While there has been little specific discussion about or focus on the use or availability of EHRs within the ED setting by states and territories, it can be assumed that EHRs are as available in EDs as they are in other parts of their respective hospitals.

2.3 Use of My Health Record in emergency departments

The nature of emergency medicine demands immediate access to health information. The My Health Record will be valuable in an ED environment. Such an environment requires a full history of the patient to ensure health care is safe and appropriate for the individual's needs. The potential benefits of supplementary information via the My Health Record support the project focusing on an ED environment.

Healthcare providers can access a patient's My Health Record, including secured documents, using an emergency access code or a 'break glass' emergency function. Such emergency access is permitted under the *My Health Records Act 2012*. This states that the authorised healthcare provider organisations are permitted to collect, use and disclose information in a healthcare recipient's digital record without consent if it is unreasonable or impracticable to obtain consent from them or if it is deemed necessary for treatment. An example could be if the healthcare recipient is unconscious in an emergency situation. In this situation, emergency access is available for five days.[6]

Low uptake can also be attributed to lack of clinician awareness. The Commission's findings from clinical safety review 7.1 showed that ED clinicians had little exposure to the My Health Record system. Additionally, the review showed that local policies regarding the My Health Record system, in accordance with the *My Health Records Act 2012*, did not help to promote overall awareness of system functions and its potential uses to ED clinicians.

The time-critical nature of access to My Health Record was emphasised by emergency clinicians consulted during the review. Clinicians reported a preference for a 'single (information technology) home', where they can access and maintain up-to-date patient information. For example, this information includes laboratory results, diagnostic imaging, private hospital attendances, and GP consultations. The clinicians who were consulted identified that patient information required to assess and manage patients is 'hard to find'. Searching for this information requires 'complex navigation' through systems, which can have a negative effect on the ED workflow.

As the My Health Record system matures and there is increasingly more information uploaded into the system, this is expected to enhance both patient and clinician utility. The transition to an opt-out environment, as part of the My Health Record expansion program, is expected to further enhance the utilisation of the My Health Record system as part of clinical care.

3. Methods

A literature review was undertaken of peer-reviewed journal articles and databases. This review was complemented by an environmental scan of international health jurisdictions and their experiences with EHRs in the ED context. Grey literature was also examined, which supplemented findings from the literature review.

3.1 Research questions

The following research questions were deduced from the project topic and were used to guide the literature review:

1. What are the benefits of using EHRs in hospital EDs?
2. What barriers and enablers affect the routine use of EHRs by clinicians in hospital EDs?

The search strategy was designed to explore the following focus areas of the EHR literature:

1. Integration of EHRs and ED patient administration systems
2. Best practice of EHR usage within the ED setting
3. Barriers to EHR clinical use, particularly safety and quality risks and impacts on workflow
4. Implications for education, training and implementation support requirements.

3.2 Terminology

A preliminary review of the area of study found that various terms are used to describe what is referred to in Australia as an EHR. With this in mind, various terms were included in the search strategy including Personal Health Record (PHR) and EMR; this is despite the fact that the latter term relates to internal, hospital-based electronic health systems in the Australian context (Table 2).

Table 2: Terminology and abbreviations associated with EHRs

Search Term	Acronym
1. Digital health record	n/a
2. Electronic health record	EHR
3. Electronic medical record	EMR
4. Electronic patient record	EPR
5. Emergency department	ED
6. Health information exchange	HIE
7. Health information technology	n/a
8. Integrated health record	n/a
9. National electronic health record	NEHR
10. Patient access electronic record	n/a

Search Term	Acronym
11. Patient electronic health record	PEHR
12. Personal health record	PHR
13. Personally controlled electronic health record	PCEHR
14. Personally controlled health record	PCHR
15. Shared health system	n/a

n/a = not applicable

3.3 Peer reviewed literature

3.3.1 Inclusion criteria

A date limit was set at 10 years, between 2007 and 2017. This period was selected due to the variable maturity levels of EHR implementation throughout international health jurisdictions.

The literature review included papers published in English. Papers also included case studies, commentaries, editorials and conference proceedings. Papers considered were required to describe qualitative or quantitative evaluation regarding clinician use of an EHR within an ED setting. A hand search of reference lists for articles that underwent a full-text review was undertaken to capture all relevant papers.

3.3.2 Exclusion criteria

Papers were excluded if emergency care was provided outside of an acute hospital setting. This resulted in the specific exclusion of emergency care delivered in an ambulatory care setting, which predominantly affected literature originating from the United States of America. Literature was excluded that did not specify that the EHR was accessible by consumers or healthcare providers external to the 'home' healthcare organisation.

Literature that focused on other healthcare settings, such as primary care, was excluded from the study. The key emphasis of the study is the emergency care setting; hence, to maintain the scope of this report, any literature that refers to the implementation of an EHR beyond the emergency care setting was excluded.

3.3.3 Search strategy

A search strategy based upon the research questions was refined with project team members and independent advice from a clinical librarian and a senior research fellow. Boolean 'strings' and operators, including the use of asterisks to encompass combinations of a parent term (for example: 'emergency*' to encompass both emergency room and emergency ward), were utilised in order to retrieve specific literature. 'Emergency Service, Hospital' was used as a medical subject heading (MeSH) in the search query. This MeSH heading and relevant entry terms contributed to the search queries, which were limited to a search of title and abstract. Consideration was given to the use of acronyms that are commonly used to describe ED settings and EHRs. Adjacency search functionality was employed for 'electronic records', to ensure the capture of EMRs or EHRs. This reflected how such terms are used interchangeably due to the location and jurisdiction of the study as described above.

Table 3: Search strategy

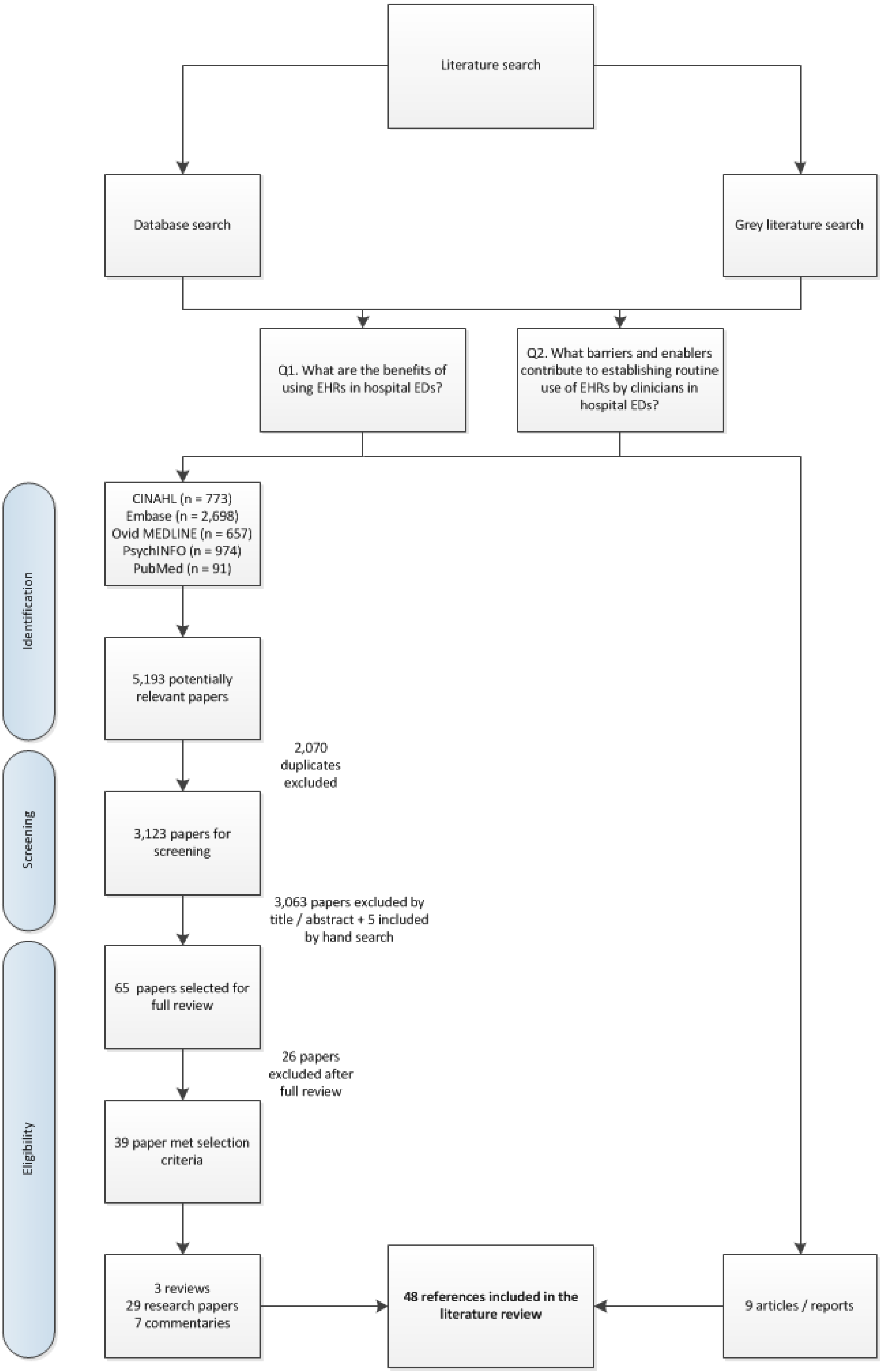
String no.	Search term
1	Emergency Service, Hospital/
2	Emergency hospital service*.ti,ab.
3	Emergency department*.ti,ab.
4	Emergency unit*.ti,ab.
5	Emergency ward*.ti,ab.
6	ED.ti,ab.
7	ER.ti,ab.
8	1 OR 2 OR 3 OR 4 OR 5 OR 6 OR 7
9	Electronic Health Record/
10	Health Record, Personal/
11	EHR.ti,ab.
12	EMR.ti,ab.
13	Personal* Health*.ti,ab.
14	Electronic adj2 (Medical or Health) adj2 record$.ti,ab.
15	9 OR 10 OR 11 OR 12 OR 13 OR 14
16	8 AND 15
17	limit 16 to yr="2007 - 2017"

3.3.4 Search results

The peer-reviewed search strategy produced 39 papers. There were 25 studies based in the United States, eight in Israel, three in Australia, and one each in Finland, Japan, and Norway.

Of the peer-reviewed scientific literature, there were 29 research papers, seven commentaries and three systematic literature reviews. The majority of research papers that employed a qualitative research design used surveys and semi-structured interviews. Quantitative studies used track log-file analysis from EHR data. Seven papers used an observational study to examine clinician interaction with an EHR system. Three papers used a mixed-method analysis, with one of these papers having employed an EHR simulation that replicated the cognitive time pressures of an ED environment.

Figure 2: PRISMA flow diagram paper search and selection process



3.4 Grey literature search and environmental scan

A pragmatic search was undertaken, which primarily focused on official websites of national health agencies that have implemented EHRs, as well as organisations such as the European Commission, the World Health Organization (WHO), the Commonwealth Fund and the Organisation for Economic Co-operation and Development. The search also included health informatics sites and grey literature repositories, including OpenGrey.

Additional grey literature was also explored via a hand search of reference lists of relevant literature, including health agency reports, conferences and professional bodies. A list of websites searched is included in Appendix 1.

The search sought to establish general information about EHR implementation to provide context as to the applicability of the each country's or each organisation's experiences, including through high-level strategy reports for digital health. It then focused on accessing specific information relating to the experience in emergency care. Additional searches via Google were conducted using terms specific to each country or organisation, for example 'ELGA' – the Austrian EHR system.

Given this broad scope, there were no specific inclusion or exclusion criteria. However, papers meeting the inclusion criteria for the peer-reviewed literature search have been specifically identified and included. These and are described in detail in the jurisdictional overview (Section 4.1).

Countries or regions with national or provincial EHR systems were the main focus of the search, owing to the similarity with the Australian context. The project brief nominated the United Kingdom (and the individual constituent parts of the UK), Austria, Canada, Denmark and Japan as suggested countries of interest. Canada was found not to have a national system. The experiences of some of Canada's provinces and territories were found to be of relevance to the research questions, and a number had robust evaluation processes for their digital health systems. These have been included as examples.

The jurisdictional search was also informed by a number of high-level documents describing the status of EHR implementation internationally. These are shown in Appendix 2, and include for example the 2015 WHO Global Survey on eHealth report.[110] Appendix 3 summarises the results of this survey in terms of the countries that indicated that they have a national EHR system, the year it was introduced and whether national legislation is in place to govern the system. Based on this, some additional jurisdictions were included in the search: Singapore, Israel, New Zealand and Ireland. It should be noted that some countries with established EHR systems are not included in this summary as they did not consider their EHR to meet the definition used in the survey, notably the United Kingdom. This highlights the limitations of this survey and the challenges relating to the terminology in this area:

EHRs are defined in the survey as[108]:

> Real-time, patient-centred records that provide immediate and secure information to authorised users. EHRs typically contain a patient's medical history, diagnoses and treatment, medications, allergies, immunisations, as well as radiology images and laboratory results. A National Electronic Health Records system is most-often implemented under the responsibility

> of the national health authority and will typically make a patient's medical history available to health professionals in healthcare institutions and provide linkages to related services such as pharmacies, laboratories, specialists, and emergency and medical imaging facilities.

While Israel has a national program, access to its health department website was not possible (denied access via Google search). Limited information was available for Singapore, Ireland and New Zealand, but all appear to be in the process of developing national approaches. Jurisdictions for which required content was not available in English were not included.

For the jurisdictions selected, including the Australian Commonwealth, states and territories, the search sought website content, policy documents, strategic plans and annual reports referring to implementation of EHR generally and specifically in EDs or other emergency care settings. The search encompassed websites focused on e-health as well as emergency care in order to capture information relevant to the emergency care setting. In view of the potential importance of education and training as factors relevant to the study, some education focused websites were also included.

3.4.1 Search results

The environmental scan, including grey literature, produced a large volume of background literature that has been used to provide context to the specific ED-related literature. This is referenced but not counted as meeting the literature review criteria. Nine documents were found that related specifically to the evaluation of EHR in EDs and met the inclusion criteria for the peer-reviewed literature (see Figure 2).

3.5 Collation and presentation of findings

The general information from the environmental scan was collated to establish profiles for the selected jurisdictions. These are outlined in section 4.1 of this report. This section also summarises the findings of evaluations specific to these jurisdictions as found in the grey literature search.

A summary of the key features of the included national EHR programs (Australia, Austria, Denmark, England, Scotland, Wales and Northern Ireland) are tabulated in Appendix 4.

The combined findings of the peer-reviewed literature and relevant grey literature in relation to the two research questions are shown in sections 4.2 and 4.3.

4. Findings

4.1 Overview of international jurisdictions implementing Electronic Health Records in emergency care

The grey literature review describes various large-scale EHR implementations, including implementation in emergency care settings.

The accuracy and completeness of shared records is variable, and implementation of EHR systems has proceeded at different speeds in different areas and settings. Some EHRs are special-purpose summary-care records stored in central repositories. Others take a decentralised approach by creating a virtual record that is assembled via links to other data repositories. Some take a combined approach, such as providing a centralised summary record that is accessed regionally through local data-sharing portals that host a regional hospital and other local service data. Other jurisdictions take a less direct approach and facilitate information exchange through the development of interoperability standards and collaborative strategies. Content, system architecture, and implementation in most jurisdictions continue to evolve.

The content of EHRs also varies considerably depending on the structure of the overall health system. In countries where general practice digitalisation is well advanced, this has formed the starting point for sharing across the health system. This contrasts with other countries where the hospital system is advanced in terms of interoperability, and therefore forms the basis of the EHR development and information-sharing.

Knowing these characteristics and foundations of EHRs is important for understanding the application in EDs. For example, data from primary care may be used differently in emergency care compared to data relating to previous hospital admissions, pathology results, and pharmacy records.

The nature and implementation of the EHRs in the included jurisdictions is described briefly in this section, together with any specific experience and evaluation in the emergency care setting.

4.1.1 United Kingdom

England, Scotland, Wales and Northern Ireland have administratively separate health systems, with different EHRs overseen by national or provincial information governance structures and infrastructure, and guided by national or provincial digital health strategies.[29, 45, 52, 79]

Each jurisdiction has a ‘summary’ record to support delivery of emergency and unscheduled care. These are accessible via national or regional portals, which host or link to a variety of other information sources. EHRs are generally not shared across borders, although there is some interoperability of selected documents between Wales and England.

Type of EHR

In England, the National Health Service (NHS) Summary Care Record (SCR) was introduced nationally in 2008 to enable system-wide access to key patient information.[72] Scotland has three different national summary records: the Emergency Care Summary (ECS) launched in 2006; the electronic Palliative Care Summary (ePCS) record in 2009; and the Key Information Summary (KIS) in 2013.[48, 55, 56] In Wales, the Individual Health Record (IHR) was implemented in 2005 and was renamed the Welsh GP Record in 2016.[71] In Northern Ireland, the Emergency Care Summary (ECS) was introduced in 2008.[55]

All systems draw information from GP records through a unique patient identifier, and store the information centrally as read-only files that cannot be changed by other providers accessing the records. SCRs are accessible via portals that host other shared information services and functions, including e-referrals and e-prescribing. The portals may be nationally or regionally based.

Record creation

Records in all jurisdictions are created on an opt-out basis by the person’s GP, except for the KIS record which is created on an opt-in basis. The KIS is a more comprehensive record intended for patients with complex needs. Uptake of the systems at a GP level are therefore high; for example, in England 99% of GP practices contribute to the SCR, and over 55 million SCRs have been created, representing 96% of people registered with a GP.[56, 72] Similarly, in Scotland the ECS was rolled out to individuals registered with a GP on an opt-out basis, and by 2006 over 99.9% of Scottish residents had a record.[33]

Access by health providers and data security

While the records are created unless the patient has chosen to opt-out, each clinician must obtain consent from the patient at each encounter in order to access the system, except in an emergency where access protocols provide for clinician access. The systems vary in terms of the access security processes, but at a minimum, users require authorisation to obtain a user name and password, and can only access the patient record if involved in the direct care of the particular patient. In England, healthcare providers must be specifically approved to receive an individual smartcard and passcode. In some systems, access is also restricted depending on the role of the person (called Role Based Access Control). Access to the systems (portals) from within health services is generally facilitated by enabling direct access from within the health service portal so that only one set of user credentials is required.

The types of healthcare providers authorised to access the records varies between the member countries. In Scotland, the ECS was initially restricted to authorised health service providers in out-of-hours medical centres, NHS 24 (telephone and online based service), and hospital EDs. Access has since expanded to include the ambulance service, hospital pharmacists, hospices and secondary-care users.

In Wales, access is broadly available to hospital-based doctors and nurses, doctors and nurses working in general practice and out-of-hours services, hospital pharmacists and hospital pharmacy technicians. A 2016 review notes that plans are in place for use of the

Welsh GP Record to be expanded to community-based pharmacists, emergency service first responders and advanced paramedics directly involved in a patient's care.[80]

In England and Northern Ireland, the records appear to be available to any health provider authorised and directly involved in patient care.

A further security aspect in place throughout the UK is monitoring and auditing of access to the records to prevent and identify breaches. For example, in England, each time an SCR is viewed, an alert is generated on a system database called the alert viewer. Future plans include enabling direct access to such alerts and records by patients. Presently, a patient can ask an organisation with authority to access their EHR to show them an access report of who has looked at their SCR; this is called a Subject Access Request.

Content

Content of the basic shared summary record is similar across the jurisdictions. In England, the SCR contains patient demographics (name, address, telephone number, NHS number) and core information consisting of medications (acute, repeat and discontinued repeat), allergies and adverse reactions. Additional information such as significant diagnoses and care plans may be added with the explicit consent of the patient. This expanded version of the record is actively promoted to better address the requirements of managing people with complex needs and has been a key factor in expanding uptake in the emergency care setting.

In Scotland, the ECR also contains basic patient details (name, address date of birth, identification number – Community Health Index (CHI) number), emergency contact numbers, medicines prescribed, allergies and adverse drug reactions. Additional information can be added in free text if agreed by the patient and their GP. Similar to the expanded SCR, the KIS, introduced in 2013 in Scotland, contains more comprehensive information including: past medical history, baseline functional and clinical status, triggers for deterioration, current care needs and arrangements, emergency contacts and next of kin details, how far to escalate care, preferred place of care, final care, palliative care, and legal issues such as power of attorney. The KIS also contains information about special alerts, for example around staff safety. The level of detail will depend on the complexity of the patient's clinical condition. About 2–3% of Scottish patients have a KIS, selected by their GPs as those with the most complex health or social care needs. This record is created on an opt-in basis and therefore does not require additional consent to access for each service encounter.

In Wales, the Welsh GP Record contains a range of information: patient's name and address, GP practice, medication, allergies, medical problems that the GP manages, and results of recent medical tests (blood tests and diagnostic imaging).

In England and Wales, sensitive information – such as information about sexually transmitted diseases, fertility and embryology, foetal terminations, gender reassignment and private discussions between a patient and their GP – is not included in the summary records. It is not clear if such exclusions apply in Scotland and Northern Ireland.

In Northern Ireland, the ECS contains information on drugs and allergies obtained from a patient's GP record. The Northern Ireland Electronic Care Record (NIECR) platform, on which the ECS is hosted, contains information from electronic records systems from hospitals and GP clinics including, laboratory tests and X-rays results, allergies, medications, and visits to hospitals (and out-of-hours centres). This platform was introduced in 2013.

Patient access and control

For all summary records in the UK, patients are not able to access the records directly and must request a copy from their GP. In Wales, however, online patient access is planned for 2017. The requirement for all health professionals to seek specific patient consent for access at each consultation is the main mechanism of patient control over the record.

Implementation in emergency departments

In England, the sharing of information to support the delivery of safe and effective patient care in urgent care and emergency services was a focus of the Keogh review into emergency services in 2013.[69] The review identified the value of the SCR in these circumstances (although not providing any specific evaluation) and has driven subsequent implementation and promotion, including the publication of a range of guides which integrate information-sharing and use of the SCR as a strategy for emergency care improvement. These resources include:

- *Transforming urgent and emergency care services in England – Safer, faster, better: good practice in delivering urgent and emergency care. A guide for local health and social care communities* (2015)[102]
- *Transforming urgent and emergency care services in England – Clinical models for ambulance services* (2015)[101]
- *A Quick Guide to Sharing Patient Information for Urgent & Emergency Care* (2015).[53]

Use of SCRs is becoming part of standard clinical care in urgent and emergency care settings, where more than 78,000 SCRs are viewed each week.[58]

Use of the SCR is specifically mentioned in NHS England's strategy document *Next Steps on the NHS Five Year Forward View* as being necessary to achieve improvements in urgent and emergency care delivery.[76] According to ongoing plans for expansion of the SCR, by December 2017 every ED, Urgent Treatment Centre and e-prescribing pharmacy will have access to extended patient data, either through the SCR or local services that share care records.[76]

In Scotland, the ECS was created in response to a change in the provision of out-of-hours primary care. Each of the 14 regional health boards operates an out-of-hours service, staffed by nurses and GPs, that provides non-emergency primary care when GP offices are closed. Each out of hours service has a central hub, and between two and nine satellite centres. Prior to 2003, Scottish GPs were required by their contract with the Health Department to provide out of hours care. In 2003, a new contract allowed GPs to opt-out of providing out of hours care, which most GPs chose to do. It was subsequently agreed that, to provide adequate quality patient care, the out of hours clinicians needed access to a subset of patient data from GP electronic medical record applications (almost all GP practices in Scotland already had EMRs). The ECS was designed to meet this need. The ECS has been in use in EDs since 2006 and is considered to be well embedded.[79] It is also now accessible (along with the expand KIS) to a range of unscheduled care providers including phone based services (NHS24), accident and emergency departments, hospital pharmacy, ambulance and out of hours clinics, as described above.

There is no specific information available on national websites regarding the implementation in EDs in Wales and Northern Ireland.

Evaluation

There is limited information available via national websites regarding the evaluation of these records in emergency care, although it was evident that pilot implementations had been conducted when the records were initially introduced.

A case study relating to the Scottish ECS is included in the European Commission's report *The Socio-economic Impact of Interoperable Electronic Health Record (EHR) and ePrescribing Systems in Europe and Beyond* (2009).[39] It is one of nine case studies evaluated using robust methodology exploring cost-benefit, time horizons of benefit and impact on different stakeholders (organisations, clinicians, citizens). The benefits attributed to ECS by the evaluation for various stakeholders are shown in Table 4.

Table 4: Benefits of the Scottish Electronic Care Record[39]

Stakeholder	Benefit	Comment
Healthcare provider organisations	Patient safety and reduced risk	Fewer technical mistakes with associated avoided effort, due to information availability
	More effective healthcare	Quality from better-informed decisions
	Integrating human resources effectively	Facilitated seamless care pathways
	Reducing patients' waiting times	Avoiding complaints
Citizens	Reducing the risks of technical mistakes at the point of care	Avoided unnecessary pain and discomfort
	Enhanced continuity and a smoother transfer between different points of care	Supporting timeliness of care
	Saved time from avoiding unnecessary or duplicate procedures	More pronounced for patients with long-term conditions and who may move location
Healthcare teams	Provide services that are more consistent with their high personal and professional standards and goal	Having the clinical and patient information they need is seen as an enormous advantage; decisions made on the basis of more information are seen as reducing risks
	Work effectively as multidisciplinary teams	Facilitated teamwork and communication
	Save time	Reduce searching for information and fewer repeated diagnostic tests
	Provide more effective and efficient healthcare	Unwillingness to return to pre e-health working environments

A smaller-scale local evaluation[93] was conducted two years following initial implementation of the ECS. The survey-based study conducted over a three-week period measured clinician experience among clinicians working in the NHS24 telephone services and in EDs. It sought feedback regarding overall utility of the record and whether it changed practice or care given.

A total of 68 replies were received from pharmacists, nurses and doctors. Overall, 93% of respondents rated the ECS as helpful or very helpful and 47% indicated that it had made a difference to their management of the patient.

NHS24 clinicians in particular reported being able to deal with queries about medication and dosage without the need to refer the patient for a face-to-face consultation. ECS was found to be particularly valuable for clinicians dealing with emergency admissions on public holidays or weekends when there is no access to GPs, and for the 'hospital at night' teams.

The value in establishing current prescribed medications was highlighted, with clinicians reporting reduced phone calls to GPs, and greater confidence in a written list compared to phone calls with the GP. The pharmacists reported that some GP practices complain if a phone call is made to check the medication, as the GP practices now feel that ECS makes this unnecessary. A further benefit was for clinicians to be able to review records of the approximately 3,000 (7%) patients per week attending an ED in a different Health Board. The Scottish NHS is organised into 14 regional boards which are responsible for the health of the populations in their areas.

More experienced clinicians working in the ED setting found that they looked at ECS records infrequently, but when they did it was for the more complex cases, where the information was considered vital. One consultant clinician said 'I only access ECS once a day, but when I do it is absolutely critical'. This leads us to consider the definition of 'embedding' in relation to these records in ED, which in turn relies on an understanding of the purpose and value.

The evaluation concluded that clinicians perceived a positive impact on patient safety associated with improved quality of the information available to them and the amount of time saved.

A second phase of the same study surveyed 300 NHS24 call centre providers.[94] It reported that 81% of 118 respondents found the ECS helpful or very helpful in a current care episode. 20% indicated that it had changed their clinical management of the particular case. Again, the benefit of accessing medication information faster than by traditional methods was highlighted. On some occasions the ECS alerted clinicians to a clinically relevant fact (for example, a nephrotoxic drug, allergy to erythromycin not penicillin) where this information was not otherwise available.[94]

A qualitative case study published in 2007 examined the system-level factors affecting the implementation of the ECS.[33] It identified critical success factors including:

- The ECS had a specific purpose (to facilitate provision of unscheduled care) and was made a clear priority by the Scottish Executive Health Department
- Clinicians were closely involved in the concept and design of the ECS: GPs decided on 'the dataset' (the clinical information to be included); the ECS project board also included clinicians from NHS24, the OOH services and emergency services

- A wide variety of clinicians and medical associations was involved in developing the security and access protocol, as well as the consent model – agreement on these documents was instrumental in securing the agreement of GPs to share their data through the ECS
- The Department provided each health board with a project manager and funds for training and software rollout at OOH centres; the main task was training OOH clinicians on how to use the ECS effectively
- Gaining the trust of GPs was a critical prerequisite for gaining the trust of citizens and the media
- The Department successfully positioned itself as the 'honest broker' between GPs (who are reluctant to expand access to the ECS because they view themselves as the guardians of their patients' records) and other clinicians (who want access to records).

In Wales, the results of a small local evaluation in emergency care were also found via the grey literature search. In Gwent, a county in south Wales[3], the Individual Health Record (IHR, now called the Welsh GP Record) was piloted in a selection of unscheduled care wards in the Royal Gwent Hospital in 2015. Aspects of the evaluation were reported in the Community Health Council Annual Report 2015–16. The evaluation focused on patient acceptability, which was measured via patient survey conducted over five days involving 117 patients. There was high patient support for the system, with the majority of patients stating they would give consent to the consultant, senior nurse and pharmacist to access their IHR summary. The report noted that giving consent to access appeared to decrease in line with the grade or level of staff within the nursing and pharmacy teams. Patients who indicated that they had already given consent to staff accessing their IHR summary felt it benefited their care by way of faster diagnosis, quicker treatment and better communication between professionals. The vast majority (91%) of patients surveyed supported the roll out of the IHR system.

4.1.2 Austria

Austria is a federal republic comprised of nine provinces. Each province is divided into districts. The Austrian healthcare system is regulated by the federal government with the exception of the hospital sector, which is regulated by the provinces. In 2004, the European Commission presented an electronic health action plan, which required all member countries to commit to establishing national strategies and plans for the development of e-health applications.[27]

EHR framework

In 2005, a treaty between the Austrian Ministry of Health and the provinces included a mandate to develop a national EHR called 'Elektronische Gesundheitsakte (ELGA)'. A framework devised in 2009 identified[30]:

- Prerequisites for ELGA which include:
  - legal measures and data protection – identifying need for specific legal regulations in regards to EHRs, for example an ELGA law
  - acceptance management – identifying the importance of collaboration with all relevant stakeholders

- Basic components of ELGA such as:
  - patient and healthcare provider indexes
  - authorisation of access to ELGA based on roles (role-based authorisation)
  - specifications for interoperability and communication between healthcare providers and sectors
  - patient access portal to ELGA health data and general health information
  - document storage registries
  - national standards for document formatting
- Core ELGA applications and services which include:
  - discharge summaries
  - medication information
  - radiology reports
  - laboratory reports.

Content

Current content available through ELGA includes medical and nursing discharge letters from public hospitals, laboratory data, radiology data, and prescribed medication (full roll-out planned for 2018).[91] Additional planned content includes:

- The patient summary – a comprehensive overview containing key information about a patient ‘at a glance’, which avoids a collection of links to data documents
- Outpatient reports
- Pathology reports
- Imaging
- Mother-child pass
- Vaccinations and immunisation status
- Wills.

The ELGA portal contains a collection of links (references) to existing health data stored in decentralised repositories.[37] Prescribed medication data are stored in encrypted form in a central repository.

Record creation

Citizens in Austria are identified through their social security number, which is used as a unique identifier. All citizens with a social security number are automatically ELGA participants (patients).

Patients can choose to opt out from ELGA fully or partially for certain functions of the system (such as e-medication); or for certain encounters or durations (situational opt-out). For non-sensitive encounters, a patient has to request a situational opt-out. For highly sensitive encounters such as HIV infections, psychiatric treatment, genetic examinations, and abortions, the healthcare provider is obliged to inform the patient actively about their rights to request a situational opt-out. This puts the burden on the healthcare providers who have to analyse and define considerations for a situational opt-out. Such considerations may include who administers the situational opt-out, who addresses the patient regarding a potential situational opt-out encounter and at what point of treatment, and when the patient can request a situational opt-out.

The opt-out can be revoked or changed at any time. However, previously saved data will not be accessible (because it will have been deleted) for patients who choose to opt in again after fully opting-out. Instead, the patient will start on an empty ELGA record. Patients can regulate their level of participation online via the ELGA portal or in writing to the ELGA opposition office.

Access by health providers

Only authorised ELGA healthcare providers and institutions are allowed and obliged to create, host and access ELGA health data via the ELGA portal. The ELGA portal is integrated into CISs.

ELGA healthcare providers (ELGA-GDA) include:

- Hospitals
- Mobile and stationary care
- Doctors
- Nurses, nursing institutions
- Dentists and dentists companies, dental practitioners
- Pharmacies.

Health professionals who cannot access ELGA include:

- Healthcare providers who were excluded from access by the patient
- Healthcare providers (for example doctors, dentists) in the service of social, state or private insurance companies
- Healthcare providers in the armed forces
- School doctors.

A patient’s data can only be accessed by ELGA-GDAs if they are directly involved in the patient’s care. ELGA-GDAs need to authenticate their identity and treatment relationship before ELGA access is granted, for example by scanning the patient’s e-card during consultations with their GP or at a community pharmacy. Proof of treatment relationship between a healthcare provider and patient is less clear in the hospital setting, with sources referring to a ‘contact confirmation service’ that grants access after patient admission is confirmed.[36, 91] The exception is during emergency situations where access is granted if deemed necessary for treatment.

By default, GPs have access to patients’ ELGA health data for 28 days after proof of treatment. Hospitals and care institutions have access to ELGA health data from the date of admission until 28 days after discharge. The extended access duration allows further retrieval of information that informs the patient’s ongoing treatment plans.

Pharmacies will only have access to ELGA health data for two hours after proof of treatment relationship. Patients can, however, shorten or grant longer term access for their primary healthcare provider or institution. The duration of access for hospitals cannot be extended.

Every access to ELGA is logged. Patients can view access records and can report any unauthorised access to ELGA online or in writing. In addition to these technical safety measures, all organisations involved in ELGA are committed to information security management protocols (ELGA Information Security Management System, or ISMS).[36] Security audits are also provided for operators of ELGA components.

Patient access and control

Patients can access their health records via the ELGA portal after electronically identifying themselves by means of using a citizen e-card or mobile phone signature.[36] Patients are given full access and rights in managing their health data. They can control the duration of access to data, hide data by erasing document references links, prevent access by a particular healthcare provider or institute, and monitor access logs.[36] However, patients cannot change or contribute to data.

Implementation

As has been the experience in many other jurisdictions, simultaneous national rollout of the comprehensive EHR has not been feasible. The rollout is therefore being undertaken in phases[30, 37]:

- **2015 (December)**
  - ELGA trialled in public hospitals and nursing homes in Styria and Vienna
  - an increase in availability of ELGA content such as radiology and laboratory results and discharge summaries achieved
- **2016–2017**
  - ELGA rolled out to hospitals in remaining Austrian provinces
  - pilot testing of e-medication function
- **2018**
  - ELGA and e-medication rollout planned for primacy care sectors.

There was no specific information available regarding the implementation within ED or other emergency care settings.

Evaluation

There were no evaluation studies available in English relating to the ELGA implementation generally or in emergency care.

4.1.3 Denmark

Denmark consists of five regions, which are responsible for healthcare service provision in hospital, primary and secondary care sectors.

The healthcare sector is characterised by extensive digitisation, widespread adoption of electronic communication between healthcare providers, and systematic use of data and digitised working procedures. However, there remains a lack of coordination and a fragmented approach, which has resulted in the deployment of multiple EMR systems in hospital and primary care sectors with very limited interoperability.[60, 61]

Reflecting the experience in other jurisdictions, a regional approach towards system rationalisation and interoperability has been adopted, and an agreement was reached in 2011 whereby Danish regions would each assume responsibility for consolidating their numerous EHR systems in hospital and primary care into a single coherent regional EHR system, with a view to establishing a national system in the future. The goal was to overcome interoperability by consolidating the number of hospital-based EHRs into one per region by the end of 2013.[60, 61]

The regions formed the Regional eHealth Organisation (RSI) to ensure collaborative and cooperative effort and vision. A special public authority – the National eHealth Authority (NSI) – was also set up by the state Ministry of Health in 2011 with the task of setting national standards for e-health in accordance with the national IT strategy as well as managing national IT projects and e-health systems, such as the Shared Medication Record which is described in further detail below.

As of 2014, the regions managed to successfully reduce the number of different EHRs to six systems.[61]

EHR Framework

The structure of the national system is not dissimilar to other jurisdictions, with the main elements comprising of an online portal, the Sundhed.dk, and the Sundhedsjournalen or the National Health Record.

The online portal, Sundhed.dk, facilitates electronic communication between healthcare providers and patients and access to health data.[99] The portal integrates and links data from hospital and primary care repositories, providing healthcare providers and residents with a single point of access to health information such as medication history, laboratory results, and medical records. Functions and services accessible on the Sundhed.dk portal include:

- Access to health record and data (National Health Record, Shared Medication Record) by healthcare providers and patients
- Access to various e-services for healthcare providers and GPs including appointments, prescription renewals, and electronic communication
- Contact and service information on other healthcare providers
- Information on health, disease and treatment (for example, medical handbook)
- Access to information on waiting times at all public hospitals and ratings of hospitals in terms of patient-experienced quality and service
- Patient-to-patient dialogue – patient networks give the patient the possibility to discuss their own disease and treatment with other patients with a similar diagnosis, especially relevant for patients with a chronic disease
- Personal homecare and hospital solutions (for example, telemedicine, telehealth)
- Access to log data by patients who can view who has accessed their health data.

The Sundhedsjournalen or the National Health Record was built upon the foundation of an existing system called ‘ejournal’.[97] The ejournal was introduced in 2007 and initially allowed healthcare providers and patients access to medical records from public hospitals. The system was subsequently expanded in 2013 to include information from GPs such as lab results and diagnoses, but not GP notes. The application was later relaunched in 2014 as

Sundhedsjournalen and provided healthcare providers and patients an overview of patient data stored across regions and within various health sectors. The Sundhedsjournalen currently contains[97]:

- Shared Medication Record
- Vaccination history
- Laboratory results
- Diagnostic imaging
- Hospital notes and treatments, including care summaries from hospital EHRs and patient administrative systems
- An overview of services and consultations received from GPs and specialists
- Allergies
- Referrals from healthcare professionals
- Contact details of primary physician and other health professionals.

The Shared Medication Record is a centralised database developed in 2008 that contains information about a patient's medication history and current prescriptions.[98] Healthcare professionals and patients can view current and previous medication regimes. Patients can also communicate to the prescribing health professional to renew medication prescription when it runs out. Only health professionals who initially prescribed the medication can update information in the SMR.

Record creation and access are governed by the following principles and requirements.

Record creation and maintenance

Patient consent for the creation of health records is not required, and patients are not allowed to refuse registration of data in health records. This is in contrast to other jurisdictions, where the preferences of the patient are central to system operation.

Only the institution or healthcare provider that has registered data on the health record can edit it. If patients find their information is incorrect, they are required to contact the department, doctor or hospital who has registered the data in order to change it.

Access by health providers

Health professionals are not required to obtain consent (implied consent) to access records for provision of treatment and care. Again, this differs to other jurisdictions such as Austria and those in the UK, which have greater levels of patient control over access to records. This has led to criticism that the widespread and direct access of information by healthcare providers endangers patients' trust in the confidentiality of personal health information retained by healthcare services.[92]

Healthcare providers in hospitals can access Sundhedsjournalen which is integrated into the hospital's CIS as part of their workstation, while GPs, specialists and patients gain access via the Sundhed.dk portal.

Regulations stipulate different access rights for different healthcare professionals. Healthcare professionals with immediate access to patients' EHRs include:

- Doctors

- Dentists
- Midwifes
- Nurses
- Social and health assistants
- Radiographers
- Ambulance technicians.

Other licensed healthcare professionals may seek authorisation for limited access to a patient's EHR.

In emergency situations, health professionals can make an 'emergency extraordinary lookup' and access locked health information without the patient's consent if the practitioner deems it necessary for emergency treatment.

While not encouraged and limited, patients can prevent certain aspects of their health data (for example, specific prescribed medication, or diagnosis) from being accessed. This must be done via the institution or health professional who registered the information. Healthcare professionals must seek permission from the patient to access locked information. Patients cannot block access to:

- Details of hospital treatments (for example, planned surgeries, which is registered on the National Patient Registry)
- Consultations with GP or specialists
- Referrals
- Details of treatment agreements with hospitals
- Laboratory results.

Patient access and control

Patients have full rights to access their health record via the Sundhed.dk portal. To access the portal, citizens must have a social security number, be over 15 years old, and have a digital signature (NEM-ID). The NEM-ID is obtained by registering in person and submitting their passport number for identification.

Data protection

Privacy and data protection are regulated locally via the data controller, which must have systems in place to ensure personal data can only be accessed and processed by health professionals with a treatment relationship. Access to any patient record is also logged with information, including the time of access and the name of the healthcare professional's organisation. Patients can monitor their log file and report any unauthorised access to the regional data protection agency. A bi-annual audit is conducted on a random sample of log files and checked for irregularities. A letter is also sent to the patient if a health professional without any treatment relation has accessed their data.

For access to health data, there is a delay between when data is first logged, to when it is made available for patient access for ethical reasons such as preventing patients from accessing data by coincidence before it is communicated by the treating healthcare provider. Hospital data is generally delayed up to 14 days, though the length of delay varies from region to region. Details about GP or specialist consultations appear approximately 45 days after the actual consultation for patient access. This has raised issues where patients are denied access to information which they may wish to know about in order to plan for future treatment initiatives.

Implementation in emergency departments

There was no specific information found regarding implementation in ED.

Evaluation

There were no evaluation studies available in English.

4.1.4 Canada

Framework

In Canada, EHR is being implemented regionally within the provinces and territories, based on a nationally developed framework defining three main components[20]:

- Point-of-care system – that ensures that all healthcare providers have compatible systems in place to send, retrieve, and manage health information within their individual health settings; for example, EMR systems in physician offices or CIS in hospitals
- Storage – a hub-and-spoke repository system where critical health information is collected and stored in jurisdictional coordinated repositories. The EHR comprises the following six core systems:
  - unique patient identifier
  - unique healthcare provider identifier
  - diagnostic imaging systems
  - laboratory information systems
  - medication (drug) information systems
  - clinical reports (for example, hospital discharge summaries, allergies and immunisation)
- Connection – a secure pathway for movement of information within provinces and territories and eventually across country, so that patient health information can be quickly accessed and updated by authorised healthcare providers.

Each of Canada's 13 provinces and territories has developed regionalised e-health strategies and systems, based on the above components, which are at various stages of implementation and maturity. Infoway, the national body overseeing this development, measures EHR deployment and adoption across jurisdictions by tracking access to data stored in repositories for the six core systems.[23] Access to the EHR for authorised healthcare providers differs across the country, with access made available through integration of various point-of-care systems such as EMR and CISs, or through web-enabled viewers that extract relevant patient data from various clinical databases and present the information in a coherent, easy-to-digest manner.

It was beyond the scope of this review to investigate the EHR systems within all of the provinces and territories. However, three EHR systems are briefly described as examples:

ClinicalConnect in Southwestern Ontario

ClinicalConnect is a secure, web-based portal which aggregates real-time, patient health information from primary care, acute care, long-term care, mental health, public health and home care sectors and includes data from provincial repositories such as laboratory information and diagnostic imaging information systems.[26]

eChart in Manitoba

The eChart was implemented in 2011 and includes data from hospital, primary care sectors and pharmacies which are uploaded to provincial repositories.[31] The repositories that are currently connected to eChart include: prescribed medication, laboratory results, immunisation records, diagnostic imaging and hospital encounters.

The Secure Health Access Record (SHARE) in Nova Scotia

SHARE is Nova Scotia's EHR.[82] SHARE is a view-only clinical portal that aggregates data from hospitals, private healthcare organisations (physician clinics, long term care facilities) and community pharmacists. Data accessible on SHARE include: hospital admission, discharge and transfer information; laboratory results; diagnostic imaging; select clinical reports such as discharge summaries, history and physicals, and consulting notes; and medication information.

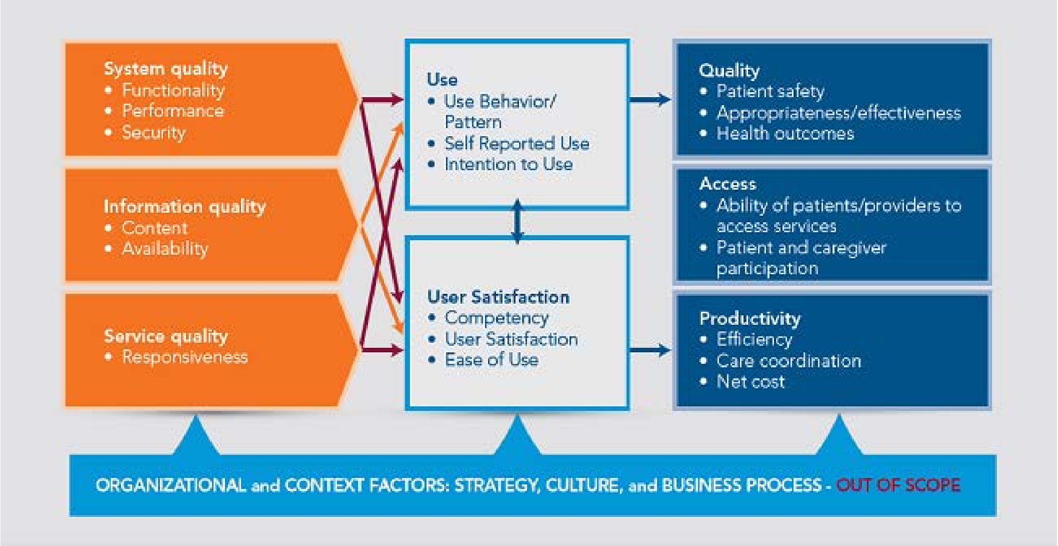
Evaluation

Canada has approached the evaluation of its e-health initiatives in a structured and systematic way, which is broadly relevant to the implementation and evaluation of My Health Record, including implementation within ED.

Infoway has developed a Benefits Evaluation Framework[18] and related resources to support understanding of progress towards national and local objectives, to assist in identifying barriers, and to facilitate communicating of successes and opportunities for improvement.[18] The Benefits Evaluation Indicators Technical Report[21] supports application of the framework by providing key indicators across focus areas, focusing on realising the EHR's clinical value. The technical report also includes measurement tools and other resources.

Benefits evaluations have been conducted in relation to the implementation of the provincial EHR systems in Southwestern Ontario, Manitoba, and Nova Scotia. Their implementation experiences are explored briefly below. There are many other resources[19] and examples of evaluations accessible online that have been conducted by Infoway, the provinces and territories and digital health researchers.

Figure 3: Infoway's Benefits Evaluation Framework[18]



Based on the Delone & McLean IS Success Model

Other key resources include:

- *Handbook of eHealth Evaluation* (2016) – a practical guide on the evaluation of eHealth initiatives[63]
- *Health Information Network Leading Practices* (2015) – a report detailing leading practices from around the world in the creation or operation of health information networks or exchanges[22]
- *Canada Health Infoway Benefits Evaluation Indicators Technical Report* (2012) – key measurement indicators and guidelines for evaluating benefits of ICT systems in health.[21]

Ontario

eHealth Ontario has recently published an evaluation report (*Benefits Realisation Update 2016*)[35] on the clinical value and progress of EHR development and implementation, based on Ontario's e-health blueprint.[34]

The report describes a combination of different evaluative methods, such a real-time studies, clinician and patient surveys, and 'data mart analysis', to gain a broad understanding of how the EHR is being used to provide patient care.

While not specific to ED, some of the benefits described include:

- Improvement in a number of performance indicators, such as '30-day readmission' and 'time to treatment'
- Increased confidence of clinicians regarding clinical decision-making
- Avoidance of lab test duplication
- Enhanced efficiency and productivity reported by users.

In addition to this main report, one small study was identified investigating use of Southwestern Ontario's EHR, ClinicalConnect, in ED. An ED physician tracked his use of ClinicalConnect over a nine-shift period in May 2015.[28] The aim of the study was to document the effects of using the EHR to check for clinical information from across the health system on patients' perception of care, and the extent to which clinical decisions changed as a result of the physician being better informed.

The ED physician saw 170 patients over a nine-shift period. ClinicalConnect was used to gather additional information for nine patients (5.3%) and influenced the care of six patients as follows:

- Three patients had previous laboratory and diagnostic information which influenced their care
- One blood transfusion was avoided by comparing the patient's current tests to historical trend
- Two admissions were avoided based on data from other hospitals (for example, diagnostics, transcription and laboratory data).

ClinicalConnect was found to be useful for complex patients because they have had investigations in other facilities and tended to have multiple complex chronic conditions (for example, cancer patients and trauma patients). Historical treatment information and laboratory results informed better care. Results from this one case suggest that use of ClinicalConnect in ED (estimated between 5-10% of presentations) can contribute to better-informed decision-making that can reduce tests, treatments and admissions for patients who can be cared for in other settings.

Manitoba

In Manitoba, a benefits evaluation study was conducted in 2012 on the first phase (early implementation) of the eChart rollout across 33 sites (primary care clinics and EDs).[32] The evaluation explored the factors affecting use of the record as well as the benefits realised from the point of view of the users, which included clinical and non-clinical users.

Methods included interviews, focus groups, an online survey, and a review of eChart usage reports for the period December 2010 to January 2012. Interviews were conducted at 19 sites with 95 individuals including physicians, nurse practitioners, allied health professionals, office managers, and support staff. The number of EDs that participated in the evaluation was small and most of the findings were not analysed separately for this setting. However, some data were useful and are described below.

Usage of the chart appeared to depend on the nature of existing information available. The eChart adoption was slower and usage lower in EDs compared to primary care, as EDs tended to rely more on their in-facility online systems or access to other already-existing external systems. This may reflect the early stage of implementation as well as the challenge of incorporating use of the chart into ED workflows. Some clinicians stated that they would probably either start using or increase their current use of e-chart when all clinical source systems were linked and additional functionality and information (for example, imaging results, ED patient discharge summaries and fact sheets) become available.

Use of eChart varied by site location, with higher frequency of use observed in southern and rural areas in Manitoba compared with urban areas. Use of eChart was also found to be higher when clinicians encountered new patients or for patients with complex medical conditions.

Participants were generally satisfied with the clinical domains accessible on eChart – medication history, lab results, immunisation history and demographics. Usefulness of the specific content domain (lab results, medication history, immunisation status, demographic data) varied for different settings (primary care versus ED) and for different clinical roles (nurse, physician, administration).

Participants also felt that information on eChart was reliable, accepting the limitations described above in terms of incomplete system linkages. It was noted that different laboratories updated their data at different frequencies ranging from daily updates to every couple of days, which could have an impact on patient care. There were also issues regarding the access to medication history associated with system screen design and search functions.

Other barriers to implementation included:

- Maturity of the digitalisation of the service leading up to implementation, including access to computer terminals in clinical areas
- Lack of clarity about when and where to access system support for various issues, including roles of internal and regional IT support
- Lack of implementation support and lack of time to learn how to use the system during busy work schedules.

Evaluation participants identified a number of enablers that may further support implementation, including:

- Offering additional support to sites during implementation
- Engaging stakeholders for feedback and suggestions for improvement
- Engaging ‘champions’ or frequent eChart users to help promote eChart – during the course of evaluation, frequent eChart users showed high enthusiasm towards eChart and had much to share about their experiences with the system. Much value was identified by users ‘telling their story’ to peers, describing lessons learned and benefits of using eChart.

The evaluation identified a number of benefits observed from the clinician perspective as summarised below. Note these are not differentiated for primary care and ED.

- **Improved decision-making** – ability to supplement information obtained from the patient using eChart to provide a comprehensive medical history on which to base clinical decisions
- **Improved patient safety** – ability to verify information reported by patients and follow-through on discrepancies and avoiding potential adverse outcomes for patients
- **Improved quality of care** – particularly for complex or challenging patients, for example for drug-seeking behaviour (eChart makes it more efficient to detect drug-seeking activity); patients with chronic diseases who are taking several medications; or where certain prescription medications have been tried but have not worked for the patient
- **Improved clinical efficiencies** – checking existing lab results; viewing patients’ history of prescribed medication from pharmacies; creating treatment plans based on established information
- **Improved organisational efficiencies** – less time on phone calls, faxes and other

information exchanges; time savings were particularly noted for teens, immigrants, mobile or transient patients, and patients with positive STI needing blood work

- **Improved access to service** – use of eChart during consultations has helped increase patients' awareness of healthcare services available to them
- **Improved clinician and patient relationships** increasing the level of confidence patients have towards clinicians.

Nova Scotia

In April 2013, Nova Scotia began implementation of the SHARE, a province-wide EHR. An evaluation study, comprising surveys and semi-structured interviews, was conducted in November and December that year to establish usage and user satisfaction with the system.[74]

A total of 496 active SHARE users participated in the survey, including 179 who worked in ED. Twenty healthcare providers (physicians, registered nurses, pharmacists, allied healthcare providers, and administration staff) participated in the interviews.

Most survey respondents in ED (67%) indicated that they used the record for less than 25% of their patients. This may reflect the value for particular patient types as identified in other studies (for example, complex needs patients from out of catchment) but this was not reported. It is also likely to reflect the early stage of the implementation, with some respondents indicating that they had not had the opportunity to incorporate the SHARE viewer into their workflow. For others, usage was low because they were using other electronic systems that they were more comfortable with; they had difficulties remembering multiple usernames and passwords or found it time-consuming to move between systems (no single sign-on). Respondents however did believe the system was a valuable source of information and that usage was anticipated to increase in the future.

The nature, extent and accuracy of information were also factors affecting usage, although this date wasn't differentiated for primary care and ED respondents. Overall, participants were satisfied with the type of content available through SHARE, although a number felt there was a lack of data such as historical data: 'More information on SHARE would compel me to start using it'. A number of participants reported additional information they would like to see available through the SHARE viewer, including historical data, mental health assessments, microbiology, cytology, blood products and transfusions, allergies, medication lists and infection control reports.

In terms of information quality, 90% of all respondents felt that the overall quality of information provided by the SHARE viewer was moderately to highly acceptable. The majority also agreed that information was relevant (93%), accurate (87%) and was provided quickly (87%). The lowest level of agreement (76%) was with respect to the completeness of information. When analysed by profession, the differences in the level of agreement was statistically significant ($p<0.05$), with 80% of nurses agreeing that information in SHARE is complete compared with 57% of physicians. Nurses (86%) agreed that the format and layout of information in SHARE is acceptable, compared with physicians (55%).

The majority of nurses (81%) agreed that the system 'allows me access to patient information more quickly' compared to doctors (68%). Similarly, 83% of nurses agreed to that it ‘allows me to look at integrated patient information more easily’ compared to 64% of doctors.

The evaluation highlighted a number of benefits experienced by clinicians using the SHARE viewer such as improved quality of patient care, particularly for those patients who receive healthcare in more than one district. Participants also liked the ability to access information on a provincial basis to a reduced the number of redundant test orders.

> If we didn’t have SHARE we would either have to call [another facility] or we’d have to get the blood drawn again, and that of course would be a test that was already done before but we had no access to the information. It’s extremely helpful.

The SHARE viewer also improved continuity of care which was facilitated by access to information and communication between districts and between patients and providers.

> SHARE seems to be a good and vital program that can be used for continuity of care no matter what environment the patient is in.

Clinical efficiency was also enhanced where healthcare providers gained a better understanding of patients’ conditions in a timely manner.

> SHARE allows me a great understanding of [a] patient’s overall condition before formulating a …treatment plan.

4.2 Benefits of electronic health records in hospital emergency departments

4.2.1 Safety

Improvement in patient safety is the leading motivator for EHR implementation.[44] Patient safety benefits from EHR use can include reduced adverse drug reactions[44], reduced radiation exposure (through unnecessary duplication of diagnostic imaging)[62], and improved compliance with evidence-based guidelines.[8] These benefits have been reported in qualitative studies of clinicians’ experience with EHR use.[39,28, 32, 39, 74]

Clinical information typically held in EHRs that is useful for ED clinicians to access may include a patient’s medications from community pharmacies, hospital discharge summaries, GP visits, allergy information, and immunisation history. This content can enhance the thoroughness of a patient examination and avoid unnecessary admissions.[12,40] Content-rich EHR environments can validate clinical decision-making due to the discovery of relevant supplementary information, which can increase clinicians’ confidence that a selected treatment plan is the most appropriate.[40] Clinical content that is typically accessible via an EHR, such as from a GP, can provide a more complete patient history, which is likely to influence a clinician’s decision to admit a patient.[13]

Timely access to the most recent data supports safe patient care.[40, 100] The literature shows that recent imaging and lab results will discourage repeat duplicate tests.[8] The avoidance of unnecessary diagnostic testing may be determined by the relevance of recent diagnostic results to the patient’s condition.[42] Therefore, repeat diagnostic tests in ED may be clinically valid and justified even though similar tests were recently performed and available in an

EHR. In this instance, recent diagnostic tests from the EHR may not avoid repeat testing in the ED, but still support patient safety if incorporated into clinical decision-making.[8]

4.2.2 Quality of care

In ED, the EHR has the potential to improve quality of care by improving clinical decision-making and improving continuity of care.

The literature shows ED clinicians access the EHR with a specific information need in mind[42], which is often for patients who have higher comorbidities or pose greater diagnostic challenges.[8] It is patients with significant complexities that are likely to be difficult to diagnose and require detailed investigations compared to patients of less acuity.[103] Thus, access to EHR content, particularly by healthcare providers that are external to the ED, will enhance the thoroughness of a patient examination and support appropriate decision-making, particularly for complex patients.[12, 32, 74]

One study[10] showed that viewing the medical history from the EHR produced a more accurate differential diagnosis for patients presenting with chest pain. Other clinical information typically found in EHR, such as previous surgeries, community pharmacy and demography are influential to all differential diagnoses.[15] A simulation has demonstrated that when ED clinicians accessed the EHR there was an increase in the quality of clinical decisions, more accurate diagnoses, and faster decision-making.[11] These findings demonstrate the usefulness of EHR content and how it assists ED clinicians to accurately and appropriately provide patient care.[11]

The availability of EHR content, particularly a patient's long-term history, is valuable for an ED clinician when determining an appropriate treatment plan.[13, 15] ED treatment also has the potential to be less invasive and achieve greater patient satisfaction if EHR content is used.[87]

A further benefit is that ED clinicians are less dependent on a patient or carer's memory recall to obtain information that could be accessed via an EHR.[88, 100] One observational study[88] showed that from 177 ED patient admissions, 37% of patients had missing information that could not be provided by the patient or carer. A lack of information has been shown to increase a patient's ED length of stay.[88] In the absence of an EHR, retrieval of relevant clinical information from patients or their carers can lead to frustration or inaccurate information.[88] This has the potential to affect clinical decision-making by ED clinicians, which could diminish the quality of care provided. EHRs have the potential to serve as a healthcare 'passport' for patients, which can assist clinicians in the provision of quality care.[100] Patients can avoid having to repeat information that is otherwise available in their EHR. Supplying this information to ED clinicians can be repetitive and cumbersome, particularly for patients that frequently seek ED treatment from multiple EDs.[57] The literature indicates that patients and clinicians can utilise an EHR as a collaborative tool that promotes shared decision-making and can enhance the quality of care provided.[51, 75]

An EHR system can enable improved communication amongst ED clinicians and between them and their patients.[9] EHRs support a shared information exchange between emergency, acute, primary and community healthcare providers, which benefits the patient by enhanced continuity of care.[62] However, patient benefits are only realised if EHR content is viewed, interpreted and applied to clinical care.[40, 41]

Clinical content can be easily retrieved and shared among healthcare settings, which is critical to forming an appropriate plan of care.[13] A comprehensive view of a patient's medical history supports the concept of seamless patient-centred care.[49] Access to clinical content from a variety of healthcare sources can advance personalised care and enhance the coordination of patient treatment across multiple settings.[49, 62]

4.2.3 Efficiency

ED workflow processes were improved when clinicians used available EHR information components.[15] Routine EHR use by ED clinicians has shown improvements in timely access to previous patient information and time taken for clinical decision-making.[11, 40] The retrieval of patient information external to the ED can improve in an EHR environment.[54, 100] Conventional access to this information, typically via fax or telephone, is considered prohibitive to time-critical ED workflows.[24] A study[40] from the United States showed that information retrieval via fax was the dominant method compared to an EHR. Once the information was successfully retrieved, ED clinicians viewed this content via the EHR on 82% of occasions, compared to 55% when obtained via fax.[40] The study demonstrated that information retrieved via the EHR was viewed 51 minutes sooner compared to fax, which reduced a patient's length of stay by 10.5% from the average length of 503 minutes.[40] This study showed that timely access to information is the likely mechanism for this information being viewed by an ED clinician.[40]

Patient treatment time has been shown to decrease when ED clinicians used an EHR system as part of their clinical care.[75] EHRs can mitigate congestion in the ED by decreasing patients' length of stay.[9] A prolonged ED visit can increase patient safety risks when access to treatment is inhibited due to high patient volumes.[42] However, the evidence for using length of stay to measure the effects of an EHR on ED efficiency is equivocal in the literature. Papers[43, 67] that support its use are contrasted with studies[9] that show prolonged length of stay may not imply inefficient performance. A study that showed an EHR had no effect on length of stay suggested this was due to the fact that patients whose EHRs were viewed had higher complexity.[14] Other papers have supported the view that EHR use is more likely with high-acuity patients.[8] Further research is justified to examine the connection between EHR use and length of stay across a variety of acuity levels. There remains strong evidence in the literature that patients' ED length of stay is extended when information is lacking[88]. This complements findings from other studies that show ED clinicians can spend 65% of their time on patient documentation.[73] The time spent by ED clinicians sourcing and documenting patient information can be reallocated to applying this information if available from an EHR.[40]

Information reconciliation during triage and medical examinations can be expedited by having access to the EHR. This information should be displayed by most recent results first, as these are likely to be most relevant to the patient's ED presentation. Routine EHR use can shift information retrieval from an exploratory approach to validating pre-existing content in an EHR. Studies[25, 100, 103] showed that EHR use was likely when data regarding recent hospitalisations was indicated to ED clinical staff. ED clinicians make use of the EHR by comparing diagnostic tests performed in the ED and retrieved results.[57] The literature suggests that diagnostic tests are more impactful on decision-making when the EHR is used for comparative purposes.[11]

Evidence to establish the effect of EHR use on patient outcomes remains scant in the literature.[40] Measurements of EHR use in the ED setting are focused on whether the clinician admitted or discharged a patient.[13] The incorporation of EHR content into ED decision-making, and the longitudinal effects on the patient's condition is vague.[14] A systematic review of 22 articles showed that no papers reported on clinical outcomes.[17] Some studies[12, 14] have explored ED readmission rates, which may provide insight into the appropriateness of decision-making and patient care once a patient departs the ED. This is explored in the next section.

4.2.4 Effectiveness

A number of studies[9, 12, 15] have found that EHR use can reduce readmissions, typically within a seven-day period. This can be attributed to improved decision-making and patient treatment plans, as a result of ED clinicians using clinical information from an EHR system.[12] This may suggest improved effectiveness of patient examinations and avoidance of unnecessary admissions.[12]

The literature does not thoroughly explore the impact of an EHR on the efficacy of critical care pathways that may reduce readmission rates.[14] Studies[14] suggest that viewing a patient's history leads to better decision-making; however, this finding remains equivocal in the absence of qualitative data that verifies clinician behaviours and thought processes. A study[14] has shown that viewing an EHR can reduce the probability of seven-day readmissions by 7.7%. This finding decreases by 0.6% for each additional year of the patient's age.[14] This may demonstrate that EHR use is more likely to reduce readmissions in a younger population, due to less complex medical conditions.[14] This finding requires scientific validation from an examination of factors that motivate clinician use, which achieves this positive patient outcome.[38]

The literature has shown that a clinician's decision to admit a patient is less likely when the EHR is accessed.[10] Information retrieved from the EHR can influence clinical decision-making regarding admission or discharge from the ED.[15] Previous history, diagnostic imaging and pathology results have shown the strongest relationship with a clinician's decision to admit.[15] This information, notwithstanding how recent and relevant the results, is expected in an EHR system and influences admission decisions.[15] One study[10] demonstrated how EHR content can be the determining factor when discerning between two closely matched differential diagnoses. For the simulated cases in this study, access to an EHR was likely to produce a decision to discharge.[10] The authors acknowledge that the study examined full EHR access or unavailability of the EHR.[10] Further research is required on the information components found in an EHR, both individual and in combination with one another, and on the effect on an ED clinician's clinical decision-making. This may reflect a realistic ED environment, in which the completeness of an EHR will vary amongst a patient population. This can affect the way in which ED clinical professions perform routine clinical tasks.[73] EHR enablers such as training and usability must be adjusted based on potentially fluctuating EHR use and application.[57] This could set clinicians' expectations and avoid abandonment of an EHR system.[100]

4.3 Barriers and enablers of routine use of electronic health records in hospital emergency departments

There is a large volume of literature addressing the factors influencing the implementation of clinical information-sharing systems. High-level reports in the grey literature provide useful context as many of these factors will apply to setting-specific implementation, such as in the ED.

In particular, an insightful report by the National Advisory Group on Health Information Technology in England reflects on the past difficulties of the ambitious and failed National Programme for Information Technology (2002–2009), and identifies a range of factors that should be considered at all levels of implementation of such programs.[106]

Written by Professor Robert Wachter of the University of California, the 2016 report draws on experience from outside of the health sector, including financial services, retail, entertainment and others, to describe the 'productivity paradox' whereby the expected outcomes of computerisation (improved quality, reliability and efficiency) failed to be realised. The report identifies a range of common failings, including[106]:

- Failure to appreciate the complexity of large-scale computerisation
- Failure to gain buy-in of end users of the new systems
- Failure to achieve ongoing engagement of end users
- Failure to change the skill mix of the end users, or to enlist new individuals with the appropriate skills to manage the change
- Failure to appreciate that digitisation completely changes the work – the nature of the work, the tasks to be done, and who does them
- Under-budgeting – either in total, or by budgeting adequately for the purchase or building of the system but failing to account for the need for implementation, ongoing training and modification or innovations
- Failure to stage the implementation and going more quickly than conditions allow.

The author highlights a key theme in this list as the notion of 'adaptive' versus 'technical' change, a duality popularised by Harvard professor Ronald Heifetz.[50] Technical changes are straightforward and follow a series of steps towards the known outcome, like following a recipe. Adaptive changes require people themselves to change and often require changes in the system. One of the problems is that when digitising large organisations and systems such as in health care, delivery appears on the surface to be a technical change, when it is in fact an adaptive change, and one of the highest order.

The report goes on to describe a number of key principles and recommendations for digital implementation, emphasising the importance of:

- Getting it right rather than getting it done too quickly, encouraging a staged approach led by those that are ready to implement
- Addressing adaptive change by ensuring long-term engagement with end users, with clarity around the goal of improving care rather than digitisation for digitisation's sake
- Developing and sustaining local workforces to include well-qualified clinicians with advanced informatics training
- Establishing local or regional learning networks to support implementation and

improvement

- Linking funding to viable implementation and improvement plans, which reflect and acknowledge digital maturity
- Embedding formative and summative evaluation to inform implementation and assess the benefits and costs, including the impact on the satisfaction of healthcare professionals.

Strategies to address these issues are common in high-level documents relating to EHR implementation (including national and regional strategy documents), and these can be usefully translated to specific settings such as ED.

Barriers to the acceptance of EHR by clinicians are also cited in relation to EHR implementation, and these too may be relevant in the ED setting. In WHO Handbook for EHR Implementation, which at the time of writing this report was planned for release in early 2018,[109] barriers to the acceptance of EHR by physicians are identified as:

- **Financial**
  - high start-up costs
  - high ongoing costs
  - uncertainty about return on investment
  - lack of financial resources
- **Technical**
  - lack of computer skills
  - lack of technical training and support
  - complexity of the system
  - lack of customisability
  - lack of reliability
  - interconnectivity and standardisation
  - lack of computers and hardware
- **Time**
  - time to select, purchase and implement the system
  - time to learn the system
  - time to enter data
  - more time per patient
  - time to convert the records
- **Psychological**
  - lack of belief in EHR
  - need for control
- **Social**
  - uncertainty about the vendor
  - lack of support from external parties
  - interference with doctor-patient relationship
  - lack of support from other colleagues

  - lack of support from management
- **Legal**
  - privacy or security concerns
- **Organisational**
  - organisational size
  - organisational type.

In relation to the ED setting it is likely that barriers and enablers will relate to a number of main interdependent areas including:

- The wider system attributes of My Health Record, including participation among health service providers and patients, governance and document security
- Attributes of the My Health Record and interfacing data systems, including the completeness and reliability of the content and interoperability with existing systems
- Organisational attributes of participating health services and EDs, including digital maturity, culture, implementation planning, training and education and IT support
- Attributes of users of the EHR, including clinicians and administrative staff
- Attributes of patients, including clinical acuity.

Ultimately, all these factors impact on two main drivers for use within ED, being the value of the EHR to a clinician's practice, and its ease of integration with their clinical workflow.

4.3.1 System-wide barriers and enablers

Many factors that influence implementation of EHR in ED will operate outside the ED and the healthcare organisation.

Patient participation

The availability of a record for a particular patient is an obvious requirement for utility of the EHR and uptake by clinicians in ED. This will in turn depend on high patient participation in the program, which is influenced by consumer recruitment processes at a system level via opt-in or opt-out requirements.

Data security is a particular factor that has influenced EHR implementation more broadly and can influence patient decisions to opt in or opt out of the system. Multiple studies have highlighted that the introduction of EHR systems has sensitised consumers to privacy-related concerns.[9, 49, 57] System governance and data security protocols are therefore important system-level factors, as described in the jurisdiction examples in section 4.

Patient control of records

Enabling consumer control of their EHR is empowering for the patient; however, limited or inaccessible content by clinicians may be a consequence. Consumer behaviour could be driven by security concerns regarding unauthorised EHR access, as above. Mental health, sexual health or HIV status are examples of sensitive information that consumers are likely to apply access controls on their EHR. This raises the possibility that less accessible clinical content may produce marginal benefit to clinicians using an EHR.[57]

Temporary access codes could be generated by a patient to enable clinician access, or 'break glass' access under emergency circumstances.[17] Emergency access is a feature of most EHR systems in other jurisdictions.[36, 55, 72, 99] However, the impact of such authorisation processes on EHR use has not been explored in the literature. A security breach of an EHR system is likely to cause reputational damage that would deter clinicians from routine use. Compromised EHR integrity, such as missing or altered information, can potentially have legal ramifications for clinicians that act on such information.[9] The literature indicates that EHR systems include sufficient privacy and security controls, which can establish trust in the system by clinicians and patients alike.[49]

Health provider participation

Participation by contributors to the dataset is also important for ensuring the completeness and accuracy of the data and therefore the confidence in the data and the uptake within ED. Campaigns to this effect have been conducted by some jurisdictions.[70] EHRs compile information from multiple data sources, which is supported by trust amongst healthcare providers regarding the quality of shared clinical content. The literature indicates that practices such as 'cut and paste' functionality in EHRs can produce errors, resulting in corrupted data being propagated to other healthcare provider organisations.[87, 95] Concerns regarding accuracy of medications information from GP records have driven the linkage of EHR to community pharmacies in many jurisdictions. [88] Data-quality strategies, such as standardised terminologies, can provide assurance to clinicians and promote EHR information exchange.[86]

Documentation and coding standards

Routine use of clinical information contained in an EHR system may introduce risks into practice, such as incorrect patient-matching and poor workflow integration.[95] These risks could be mitigated with guidelines for 'best-use' and clinical documentation standards.[75] This particularly applies to discharge summaries, which have shown to be a favoured information source that clinicians seek from an EHR.[88] ED staff are often critical of poor-quality discharge summaries and their limitations to change their templates independently of their software vendor.[86] It is recognised that this cannot be achieved without the cooperation of the software provider industry. Such standards would be best led as a system-wide approach at a national level.[95]

The utility of EHR clinical content can be enhanced by establishing a codified data structure. A structured format for entering clinical information would support consistent interpretation and practice.[75] National clinical terminologies could support the standardisation of EHR content. EHR data quality is an inhibitor of clinician use that could be overcome by established data standards.[75, 95] National data standards underpin the utility of EHR systems in most jurisdictions.

Secondary uses of data, such as research, public health, and health services planning, may arise from standardised EHR data; however, this may have minimal impact on direct patient care and thus on routine use by ED clinicians.

User engagement

Finally, successful implementation begins at the system level. A well designed system that considers user perspectives and places emphasis on user engagement from the very beginning of the IT solution development is the one that will be used and will provide value.[35]. High-level digital implementation strategies that integrate with emergency-care strategies at a similar level have been found to be beneficial in driving change.[69]

Demonstration of value including patient outcomes

A cited clinician motivator is an improvement to patient safety through EHR implementation.[44] A 'value-of-information' model could be employed to demonstrate positive changes to clinical decision-making following interrogation of supplementary information contained in an EHR.[17] 'Best-use' cases could incentivise clinicians to regularly access the EHR; however, there are limited studies that show the impact of EHR use on patient outcomes.[38] Improved clinical decision-making and patient throughput in an ED are also measures of EHR usefulness.[9]

System- and organisational-level implementation needs to incorporate evaluation to demonstrate clinical value and thus support ongoing implementation and improvement. The Canadian Benefits Evaluation Framework is a useful model in this regard.[18,35]

4.3.2 Record and interface-related factors

Content

Routine use of an EHR depends on the clinical content of the record, including the nature, completeness and accuracy of the data. The literature shows that healthcare providers are unlikely to continue using an EHR if the information they seek is unavailable or unreliable.[9, 40, 95] As above, this is influenced by a range of system-level factors.

The use of 'flags' or 'push' alerts may encourage routine use, to notify clinicians that information is contained in the EHR.[15] Notifications may assist clinicians in avoiding a patient's EHR if it were completely devoid of content, which may overcome clinician discouragement had this record been accessed.[57, 95] A study has shown clinicians prefer visibility regarding what clinical documents are available in the EHR rather than accessing the system to discover whether clinical documents were uploaded to a patient's record.[25] Regular access and incorporation of EHR-related content into emergency care could be realised when clinicians are automatically aware that such information exists.[40]

The availability of relevant information to support decision-making in ED has been shown to be important for enabling use of EHR. In particular, access to pathology and imaging results, previous encounters, such as GP shared health summaries, and discharge summaries from other hospitals can enable clinicians to make better diagnostic and treatment decisions.[9,15] This includes the decision to admit or discharge a patient.

A content-rich EHR, which is typically a driver of routine use[42], could increase decision complexity of busy ED clinicians with extreme time constraints.[14, 15] Content-rich EHR environments can validate clinical decision-making, by increasing confidence on a selected treatment plan, or the discovery of unanticipated useful information. [32, 42, 74, 100] The introduction of the more comprehensive KIS in Scotland and the ‘enriched’ SCR in England reflect efforts to enhance the value of the record, particularly for patients with complex needs.[46, 78] This shows that routine EHR use by ED clinicians is encouraged regardless of whether information discovered in an EHR system changes the emergency care provided. Validation of existing treatment plans based on EHR content can also support ED workflows.[11, 42]

The importance of dispensed medications in forming an appropriate emergency care plan is a consistent finding from the literature.[13, 16, 88] Accuracy of this information may be important in ensuring routine use of the EHR in ED. For example, an evaluation of the Scottish system found 36% of users in the NHS24 phone-based service found the medications recorded did not always align with the patients’ reported medicines.[94] Further research shows that dispensed medications from community pharmacies may have greater accuracy compared to medication records from GPs.[88] Thus linking of EHR systems to pharmacy repositories is now a feature of some EHR systems, as described earlier.

ED clinicians emphasised that clear, up-front documentation of known allergies and records of adverse drug events would increase their likelihood of EHR routine use.[9] The literature has shown that clinicians prioritised previous medications and allergies in an EHR, compared to other clinical documentation.[13]

Lack of clinical content in an EHR can result in stress on both patients and staff, which could contribute to additional workload for the latter.[88] Findings from a study[88] suggest that insufficient clinical content could contribute to a longer length of stay for ED patients. This is repeated in the literature, which suggests incomplete patient records can impede care coordination and introduce inefficiencies.[62]

Timeliness or currency of information is also important. Clinician perceptions on EHR-related risks focus on the potential extended downtime of an EHR system as the most serious safety concern.[85] Access to the most recent data is another safety concern[85], which has a particular effect in the time-poor environment of ED.[15] In a Canadian evaluation, it was noted that different laboratories updated their data at different frequencies ranging from daily updates to every couple of days, which could have an impact on patient care.[32]

System interface

Clinicians expect fast response times for EHR access and review, with a study quantifying this as five minutes or less.[65] The usability of an EHR is therefore dependent on its integration with the ‘in-house’ ED CIS.[95,75] Single sign-on access to an EHR via internal ED systems has been prioritised by jurisdictions[55] and must be achieved to encourage routine use by clinicians.[24, 95] This should be considered while balancing information security and patient control considerations.

Visibility as to whether an EHR is available for a particular patient is also most effective when incorporated into the ED CIS.[95]

Record presentation and functionality

The type and presentation of information contained in an EHR has been shown to influence clinicians’ behaviour and interaction with the system.

While access to adequate content is an enabler, a summarised display of information from the EHR is preferred by clinicians in an emergency care setting.[88] The literature shows that EHR access by clinicians decreases when information is not displayed in a summary format; this is compounded during busy periods.[88, 103] Given the time-poor environment of an ED, the value of clinical content from an EHR may be enhanced if limited and summarised for emergency care settings.[88] The absence of EHR summary data leads to frustration amongst ED nursing staff.[100]

In contrast, a study has shown that clinicians insist on the importance of all types of clinical information typically found in an EHR; however, most clinicians used previous history, medications and allergies for clinical decision-making.[13] This polarising view suggests that healthcare organisations may need to determine the depth of information provided to ED clinicians, which supports routine use. EHR use may be enhanced by user-friendly search functionality that could limit the content viewed by an ED clinician[9] and improve speed of access.[65] This should be considered during the design of an EHR, as an overload of information could introduce unintended safety consequences.[9] Poorly organised data, unable to be categorised or trended, will deter routine use by clinicians.[75, 95] The same applies should clinicians have exceeded a certain amount of keystrokes or multiple screens to navigate an EHR.[75, 95] EHR system features such as checkboxes and alerts may encourage routine use; however, the literature cautions ‘alert fatigue’ in some instances.[75] Clinicians are unlikely to use search and filter functionality to isolate specific EHR content during peak demand periods.[95, 103] EHR adoption will be impeded if EHR design does not reflect clinicians’ preferences and workflows.[9] Clinicians are then likely to revert to obtaining information locally, such as ED-based diagnostic imaging and pathology.[13] The literature highlights the importance of understanding ED clinicians’ habits with EHRs[103], in order to maximise EHR use.[13]

4.3.3 Clinician-related factors

Clinical background

The peer reviewed literature predominantly focuses on EHR use towards medical staff. This may limit the application of literature findings to the wider ED workforce; despite that ED workflows are completed by a variety of clinical professions.[9, 84] A qualitative study[100], using direct observation and semi-structured interviews, demonstrated that nursing staff used an EHR to retrieve patients’ recent hospitalisations. In contrast, nurse practitioners and doctors sought more open-ended data, and reviewed all EHR data retrieved to determine the application to patient care.[100] Another study showed that EHR access to both medical and nursing staff increased EHR usage compared to a medical-only model.[57] These studies indicate the value of a multidisciplinary approach regarding the integration of EHR systems and ED workflows. A team-based EHR program has demonstrated robust planning and greater implementation success.[96]

Demographic factors

Demographic factors of ED clinicians have been shown to affect EHR usage patterns and behaviours. A study[89] regarding the implementation of EHRs in the EDs of a two-hospital system revealed that EHR processing times of older ED clinicians was higher compared to a younger cohort. However, the older cohort gained efficiency and no differences remained between the two groups 10 months after implementation. Whilst younger ED clinicians showed greater adaptability to newly implemented EHR technology, routine use will achieve efficiencies over time that will neutralise any impact regarding age. It would appear from this study that an increase in ED patient processing time, immediately following an EHR implementation, may be inevitable. Routine use can produce efficiency gains and exceed pre-implementation baseline levels. ED clinical staff should be encouraged to routinely use the EHR system rather than abandoning it. This study supports this theory as, on average, processing time decreased by 0.014 percentage points for every additional patient treated. There is a negative association between EHR system familiarity and processing time.[89] Another study that surveyed three neuroradiologists of varying experience showed the most experienced clinician had rated EHR-retrieved data as having the highest clinical impact.[41] While the generalisability of this study is limited due to the small study cohort, this finding could indicate that experienced clinicians should take leadership roles to support EHR adoption.[59] An EHR implementation plan has a greater likelihood of success with the support of senior ED clinicians, despite these users potentially being deterred by their own slower processing times.[89]

Attitudes

Clinician attitudes can impede or enable uptake of EHR more generally and within the ED.

Clinicians' attitudes towards EHR show a low tolerance for any increase in time to complete ED workflows. Clinician behavioural traits and perceptions of EHR usability and usefulness can present challenges to encourage and sustain routine use.

Attitudes are closely aligned to knowledge and skills, and most jurisdictions highlight in their strategies the importance of training and education in supporting the capacity for implementation and securing user confidence, uptake and satisfaction.

Reflecting the importance of clinical support for implementation, some jurisdictions specifically acknowledge and prioritise the negative perceptions of medical staff in their planning documents.[52]

4.3.4 Patient-related factors

Clinical complexity and acuity

The value of the record for particular patient groups may be an enabler for use of the EHR for particular populations.

As shown in one study, there may be greater value of EHR content for more complex patients and when there is clinical uncertainty.[14] This could apply to patients requiring immediate clinical attention, as these patients are likely to be unconscious or disoriented.[11] EHR use was positively associated with other patient characteristics such as co-morbidities[8] and, frequent ED attendance.[103] The literature shows a relationship between EHR use and patient factors, such as acuity.[13, 73] However, studies showed that EHR use deteriorated during periods of high ED use or overcrowding[25], particularly for patients with fewer complications.[64, 65]

Caution must be exercised when using these factors to calculate ‘routine use’, as the measurement could fluctuate based on the acuity of the ED patient cohort. Demographic information can provide insight into the acuity of a particular ED, with low socioeconomic status being a potential indicator of co-morbidities and chronic conditions. Hence, the health status of an ED’s patient catchment area could indirectly determine clinicians’ practices regarding EHR usage.

Patient participation and attitudes

As previously noted, routine use of EHR by ED clinicians will be positively associated with high rates of patient registration. This will largely be influenced by whether patients are registered to an EHR via an ‘opt-in’ or ‘opt-out’ model. In turn, patient participation will be influenced by factors such as their perceived benefits and their confidence in data security and control.

One small study from the grey literature sought patient feedback regarding use of the EHR to support unscheduled care. The majority of the 117 patients involved were supportive of clinicians accessing their health record, believing it to contribute to better and faster care, and better communication with health professionals. However, the willingness to provide consent decreased for lower-level staff.

4.3.5 Organisational factors

A barrier to successful EHR implementation and adoption can be the local healthcare organisation environment. This may include insufficient infrastructure and funding, change management, and organisational culture and readiness.[75] In turn these impact on the ability of the organisation to address key issues such as the integration of EHR into ED workflows.

Integration with ED workflows

A frequently cited barrier to routine use of EHR systems by clinicians was the detrimental effect on ED workflows.[9, 54, 95] Interoperability between EHR systems and existing CISs is an enabler of routine use, as previously discussed, and this impacts on workflows.[75] Conversely, integration of an EHR with ED clinicians’ workflows can demonstrate benefits to patient care and support routine use.[100,49]

There is a perception among clinicians that the introduction of EHRs will disrupt workflows and result in more time spent on clinical documentation. The literature supports this perception, evidenced by studies that show time to complete work immediately following an EHR implementation exceeded pre-EHR baseline levels.[9, 75] EHR implementations have shown to result in reduced clinician productivity, with productivity returning to baseline levels after three[59] to four months.[87] In some instances, clinician productivity improved beyond baseline levels after 10 months.[89] This demonstrates the importance of a realistic communication strategy to clinicians to mitigate discouragement and fatigue.[100]

Workarounds may be attractive to clinicians who wish to avoid time-intensive processes, which may be exacerbated during high patient volume periods in an ED.[73] An observational study highlighted the importance of clinician engagement prior to EHR implementation, in an effort to address such EHR limitations.[100]

To minimise the impact of EHR implementation on time-critical ED workflows, the literature suggests that clinician requirements are ideally identified prior to development and implementation of an EHR system. By identifying such requirements prior to EHR implementation will support better integration of the EHR with existing systems and infrastructure.[73] EHR use should be determined by ED clinicians themselves, as they are familiar with what points of emergency care will influence usability. For example, an observational study showed that the majority of ED clinicians used an EHR following a patient examination, as opposed to either before or during.[88] A clinical-led approach will support local decision-making regarding EHR use.[9] This approach may encourage clinician ownership and overcome the perception that EHRs have a detrimental effect on ED workflow. To overcome resistance to routine EHR use, users must embed the EHR into routine processes such as patient history-gathering, handover, clinical pathways, patient transfers and triage.[54] Consultation with ED clinical staff, led by senior clinical leaders, can validate the most suitable ways to 'hard-wire' the EHR into workflows and accomplish routine use. Adjustments to workflows need to occur as additional clinical content becomes available, particularly diagnostic imaging and pathology. Optimisation of EHR integration with ED workflows must occur in a post-implementation environment.[95] Low EHR adoption and usage are likely consequences should optimisation fail to occur.

EHR use may be encouraged if incorporated with clinical guidelines.[54] Conversely, routine EHR use is inhibited in the absence of guidelines that support EHR clinical practice.[75]

The implementation of an EHR will change the communication patterns and practices of ED clinicians.[43] Any disruption caused by these changes should be accounted for by an EHR implementation team; otherwise, EHR adoption may be compromised.[96]

ED and organisational culture

The ED environment could influence the way in which clinicians interact with an EHR system. An American study[62] undertook a retrospective analysis of ED diagnostic imaging patterns over a three-year period. This study showed that clinicians associated with larger EDs are more inclined to repeat diagnostic tests otherwise found in an EHR. This finding is attributed to the cultural preference of larger EDs and their more intensive use of medical technology. Greater availability and capability of diagnostic imaging may take precedence compared to reliance on previous results contained in an EHR. A Japanese survey study of 215 hospitals suggested that teaching hospitals were most likely to use EHRs.[54] The study lacks any explanation as to why teaching hospitals possess EHRs compared to their non-teaching counterparts. It is speculated that teaching hospitals may attract more funding to support an EHR implementation. The literature has shown that small hospitals and non-teaching hospitals are less likely to overcome barriers related to EHR implementation, including financial issues.[44]

Infrastructure and digital maturity

The successful implementation of EHR systems is contingent on infrastructure.[96] The speed of an EHR system may be a stronger determinant of clinician use compared to access and content.[65]. Poor infrastructure will impede routine use, as often this affects speed of access and retrieval of information from the EHR.[65]

Surprisingly, there were no studies between the time taken to retrieve patient information from an EHR compared to conventional methods, such as telephone- or fax-based approaches.[40] The latter are believed to be the most time-consuming.[24] Time saved by obtaining information expeditiously from an EHR can improve the likelihood that such information will be incorporated into clinical decisions.[40] An American study[87] showed that clinicians had little tolerance for EHR delays lasting more than three seconds. Rural EDs may be predominantly affected, as connectivity outside metropolitan areas can be limited.

Designated clinician workstations and large screens that minimise scrolling have been suggested to encourage EHR adoption.[87] Infrastructure and software functionality impediments must be rectified to deter clinicians from introducing workarounds.[75, 86, 96]

Overall digital maturity of organisations is also a factor that may enable or impede EHR implementation in general and within the ED. Some jurisdictions incorporate measures of digital maturity to inform expectations and guide planning within individual services and to prioritise resource allocation.

Failure to invest in EHR infrastructure may impede timely access, and could have a flow-on effect on retrieval and application of EHR content.

Training to support implementation

Most other jurisdictions highlight the importance of training and education in supporting the capacity for implementation and securing user confidence, uptake and satisfaction. The education focuses not only on the use of the system per se, but also on governance requirements to ensure users are well aware of their obligations in this regard. Most authorisation processes mandate such governance training.

Reflecting the importance of training and education in achieving the vision of digital health care, the Health Education England Strategic Framework[77] (updated February 2017) identifies:

> Health and care organisations must discard old ideas about IT skills. In future, all members of the health, care and social care workforce must have the knowledge, skills and characteristics that are necessary to embrace information, data and technology, appropriate to their role.

This broader concept of integrating digital education into health education is worthy of consideration, alongside specific education in relation to the My Health Record.

Specific resources to raise awareness and support uptake of EHR in emergency care have been developed. Some examples include:

- Summary Care Record (SCR): The value of the SCR in Urgent Care (YouTube video)[70]
- The NHS Summary Care Record: Supporting person-centred coordinated care (PowerPoint slide)[46]

In other jurisdictions such as Alberta in Canada, learning centre websites[2] have been developed to facilitate access to educational material.

Integration of information-sharing into emergency care planning at all levels appears to have been successful in supporting the uptake of the SCR in England. This has flowed from the Keogh Review conducted in 2013[69], which has led to *Transforming Urgent and Emergency Care Services in England* initiative.[47]

Uptake and use of an EHR by ED clinicians would be strengthened by a succinct clinician training program, integrating use with ED workflows. EHR training for ED staff should be delivered as part of training for use of the local CIS. The absence of dedicated training programs has resulted in lower EHR usage.[57] The recommended approach includes the following:

- Initial training should occur two weeks prior to a 'go-live' EHR launch[43]
- Super-users have shown to contribute to successful implementations, with these users being doctors or nurses who had no patient care responsibilities and functioned only to support clinical staff in using the EHR system[59]
- Ongoing EHR training should be frequent and correspond to emergency medicine clinical rotations of Junior Medical Officers and Registrars, as well as mechanisms for new staff recruitment[57]
- Regular staff feedback forums, refresher courses and 24-hour support have been known to support routine use.[57, 96]

An EHR simulation training environment could demonstrate the benefits to emergency care and encourage clinician use. An Israeli study[11] conducted simulations of an EHR to emergency clinicians that showed additional information contained in an EHR resulted in more accurate clinical decisions, as clinicians were able to discern closely-matched differential diagnoses. This study showed that clinicians who accessed an EHR had reduced their time for diagnosis and management by an average of two minutes. Findings from this study showed that access to an EHR can improve timeliness and accuracy of clinical decision-making, which is particularly useful in an ED environment that includes patients who may be cognitively unable to provide information that may be available via an EHR. EHR simulations that replicate an ED setting can encourage use by clinicians without impacting real patients.[10] Another opportunity to promote EHR use was the inclusion of case studies in training programs that demonstrate 'best-use' of the EHR system.[51] This can highlight how the system can be applied to emergency care and could drive clinician uptake. Localising simulations and case studies based on the hospital's patient demographic and ED workflow will further promote the usability and usefulness of an EHR.[75]

Organisational planning

The importance of establishing a planned and systematic approach at an organisational level is a common theme in high-level jurisdictional plans. This is illustrated in Wales through an example of a local planning document.[52] This highlights that individual organisations need to gain a full understanding of their local situation, including local barriers and enablers, and to plan accordingly.

5. Conclusion

EHR systems have the potential to assist clinical decision-making, which in turn leads to the delivery of high-quality patient care. An EHR enables expeditious retrieval of supplementary health information, which is particularly vital in a time-critical environment such as the ED, and can reduce reliance on information from patients and carers.

The literature highlights a number of barriers regarding uptake of EHR in ED that are repeated across emergency care settings, irrespective of size and patient demographics. The literature indicates that EHRs can improve patient safety, particularly by reducing adverse drug reactions and unnecessary duplication of diagnostic imaging. Improvements in patient care are influenced by the involvement of clinicians in determining how EHR routine use is integrated with ED workflows.

Despite the literature demonstrating benefits on ED workflows, EHR systems have not been embraced by clinicians, who are seemingly averse to any change that prolongs patient treatment time. Adoption is inhibited by entrenched ED clinical practices of treating a patient’s immediate symptoms. Implementation teams should acknowledge the detrimental impact on time and clinician productivity that EHRs are likely to have in the short term. The recovery and improvement of clinician productivity, compared to baseline levels, has been widely documented and should be leveraged as a motivator for routine use.

The literature supports the notion that training and awareness should accompany any EHR implementation. Equal consideration should be allocated to factors that prepare clinicians for organisational change. Senior ED clinicians, of all clinical professions, should lead EHR incorporation into workflows and clinical processes. ED clinicians typically source additional clinical information via conventional methods such as fax and phone. An EHR system would substitute this existing process and reduce time taken for patient history gathering.

Clinicians should further develop their understanding of when and how to meaningfully use EHR content, in order to maximise safety and quality of care. The literature indicates that EHR content can produce a greater yield for patients with higher complexities, which in turn can improve patient examination thoroughness and clinical treatment.

EHR system governance can provide assurance to clinicians and develop trust. Data quality assurance and standards for entering information into an EHR can improve information exchange in a structured format.[9] The interpretation and application of EHR content enables improved discernment regarding closely matched differential diagnoses. ED clinicians are motivated to adopt and routinely use an EHR when best-use cases are demonstrated.

The literature remains mixed on valid measures of EHR use, as well as post-implementation optimisation of the EHR system. Nonetheless, the opportunities to improve patient care via the application of EHR content to clinical practice are universally acknowledged. Government organisations are investing in EHR implementations across international health jurisdictions, even in the absence of robust benefit realisation frameworks. Only when EHR outcomes research catches up with implementation will routine clinician use be accomplished.

6. References

1. ACT Health. e-Health records. [cited 2017 Sept 19].

2. AlbertaNetcare. Alberta Netcare Learning Centre. [cited 2017 Sept 28].

3. Aneurin Bevan Community Health Council. Annual Report 2015-16. 2016 [cited 2017 Sept 28].

4. Australian Digital Health Agency. Clinical Documents. [cited 2017 Sept 28].

5. Australian Digital Health Agency. National Digital Health Strategy. 2017 [cited 2017 Sept 19].

6. Australian Digital Health Agency. Managing access, privacy and security. April 2016 [cited 2017 Sept 28].

7. Australian Digital Health Agency. My Health Record Statistics – at 10 December 2017. December 2017 [cited 2017 Dec 19].

8. Bailey JE, Wan JY, Mabry LM, Landy SH, Pope RA, Waters TM, et al. Does health information exchange reduce unnecessary neuroimaging and improve quality of headache care in the emergency department? Journal of general internal medicine. 2013;28(2):176-83.

9. Ben-Assuli O. Electronic health records, adoption, quality of care, legal and privacy issues and their implementation in emergency departments. Health Policy. 2015;119(3):287-97.

10. Ben-Assuli O, Leshno M. Assessing electronic health record systems in emergency departments: Using a decision analytic Bayesian model. Health informatics journal. 2016;22(3):712-29.

11. Ben-Assuli O, Sagi D, Leshno M, Ironi A, Ziv A. Improving diagnostic accuracy using EHR in emergency departments: A simulation-based study. Journal of biomedical informatics. 2015;55:31-40. Epub 2015/03/31.

12. Ben-Assuli O, Shabtai I, Leshno M. The impact of EHR and HIE on reducing avoidable admissions: controlling main differential diagnoses. BMC Med Inf Decis Mak. 2013;13:49.

13. Ben-Assuli O, Shabtai I, Leshno M. The influence of EHR components on admission decisions. Health and Technology. 2013;3(1):29-35.

14. Ben-Assuli O, Shabtai I, Leshno M. Using electronic health record systems to optimize admission decisions: the Creatinine case study. Health informatics journal. 2015;21(1):73-88.

15. Ben-Assuli O, Shabtai I, Leshno M, Hill S. EHR in emergency rooms: exploring the effect of key information components on main complaints. Journal of medical systems. 2014;38(4):36.

16. Ben-Assuli OS, I.; Leshno, M.; Hill, S. Improving medical decision-making using electronic health record systems. Thirty Fourth International Conference on Information Systems. 2013.

17. Bowden T, Coiera E. The role and benefits of accessing primary care patient records during unscheduled care: a systematic review. BMC medical informatics and decision making. 2017;17(1):138. Epub 2017/09/25.

18. Canada Health Infoway. Benefits Evaluation Framework.

19. Canada Health Infoway. Benefits evaluation toolkit. [cited 2017 Sept 25].

20. Canada Health Infoway. Electronic health records. 2017 [cited 2017 Sept 22].

21. Canada Health Infoway. Canada Health Infoway Benefits Evaluation Indicators Technical Report. April 2012 [cited 2017 Sept 28]

22. Canada Health Infoway. White Paper: Health Information Network (HIN) Leading Practices. December 2015 [cited 2017 Sept 28].

23. Canada Health Infoway. Annual Report 2016-2017. July 2017 [cited 2017 Sept 28].

24. Carr CM, DiGioia CH, Wagner J, Saef SH. Primer in health information exchange for the emergency physician: benefits and barriers. South Med J. 2013;106(6):374-8. Epub 2013/06/06.

25. Carr CM, Gilman CS, Krywko DM, Moore HE, Walker BJ, Saef SH. Observational study and estimate of cost savings from use of a health information exchange in an academic emergency department. The Journal of emergency medicine. 2014;46(2):250-6.

26. ClinicalConnect. ClinicalConnect. 2017 [cited 2017 Sept 24].

27. Commission of the European Communities. eEurope 2005 Action Plan: An Update (PDF 229KB). May 2004 [cited 2017 Sept 28].

28. Connecting South West Ontario (cSWO). Benefits Realization: Improving care in emergency departments for patients with complex conditions (PDF 317KB). eHealth Ontario; 2016 [cited 2017 Sept 28].

29. Department of Health. The Government's mandate to NHS England for 2017-18 (PDF 493KB). March 2017 [cited 2017 Sept 28].

30. Duftschmid G, Dorda W, Gall W. The ELGA initiative: A plan for implementing a nationwide electronic health records system in Austria (PDF 97KB). 2009 [cited 2017 Sept 28].

31. EChart Manitoba. How it works. [cited 2017 Sept 24]; Available from: http://www.echartmanitoba.ca/hcpHowItWorks.html.

32. eChart Manitoba. eChart Manitoba release 1: a benefits evaluation. 2012 [cited 2017 Sept 21].

33. Edwards J. Case Study: Scotland's Emergency Care Summary Is a First Step Toward a National Health Information Exchange (PDF 127KB). Gartner; June 2007 [cited 2017 Sept 28]; Available from:.

34. eHealth Ontario. Ontario's Ehealth Blueprint (PDF 1.6MB). 2014 [cited 2017 Sept 15].

35. eHealth Ontario. Benefits Realization Update 2016: Planning and reporting (PDF 5.7MB). May 2016 [cited 2017 Sept 26].

36. ELGA. Frequently Asked Questions (FAQ) [translated in English].

37. ELGA. The Electronic Health Record (ELGA) in Austria (PDF 165KB). October 2015 [cited 2017 Sept 28].

38. Ellsworth MA, Dziadzko M, O'Horo JC, Farrell AM, Jiajie Z, Herasevich V, et al. An appraisal of published usability evaluations of electronic health records via systematic review. Journal of the American Medical Informatics Association. 2017;24(1):218-26.

39. European Commission. The socio-economic impact of interoperable electronic health record (EHR) and ePrescribing systems in Europe and beyond (PDF 581KB). October 2009 [cited 2017 Sept 28].

40. Everson J, Kocher KE, Adler-Milstei J, Adler-Milstein J. Health information exchange associated with improved emergency department care through faster accessing of patient information from outside organizations. Journal of the American Medical Informatics Association. 2017;24(e1):e103-e10.

41. Franczak MJ, Klein M, Raslau F, Bergholte J, Mark LP, Ulmer JL. In emergency departments, radiologists' access to EHRs may influence interpretations and medical management. Health affairs (Project Hope). 2014;33(5):800-6. Epub 2014/05/07.

42. Gordon BD, Bernard K, Salzman J, Whitebird RR. Impact of Health Information Exchange on Emergency Medicine Clinical Decision Making. The western journal of emergency medicine. 2015;16(7):1047-51. Epub 2016/01/14.

43. Handel DA, Hackman JL. Implementing electronic health records in the emergency department. The Journal of emergency medicine. 2010;38(2):257-63. Epub 2008/09/16.

44. Handel DA, Wears RL, Nathanson LA, Pines JM. Using information technology to improve the quality and safety of emergency care. Acad Emerg Med. 2011;18(6):e45-51.

45. Health and Social Care Board. eHealth and Care Strategy for Northern Ireland: Improving health and wealth through the use of information and communication technology (PDF 5MB). March 2016 [cited 2017 Sept 28].

46. Health and Social Care Information Centre. Case study: Creating Summary Care Records with additional information is simple and very effective (PDF 370KB). 2016 [cited 2017 Sept 28].

47. Health Sciences North. Transforming Emergency Care through a Transitional Strategy. April 2013 [cited 2017 Sept 28].

48. Healthcare Improvement Scotland. Electronic Palliative Care Summary (ePCS). [cited 2017 Sept 12].

49. Heart TB-A, O.; Shabtai, I. A review of PHR, EMR and EHR integration: A more personalized healthcare and public health policy. Health Policy and Technology. 2017;6(1):20-5.

50. Heifetz R, Laurie D. The work of leadership. 1997 [cited 2017 Sept 19].

51. Househ MSB, E.M.; Rohrer, W.M.; Kushniruk, A.W. Developing a framework for meaningful use of personal health records (PHRs). Health Policy and Technology. 2014;3(4):272-80.

52. Hywel Dda University Health Board. Delivering the benefits of Digital Healthcare within Hywel Dda University Health Board 2016-19 (PDF 1.3MB). March 2016 [cited 2017 Sept 28].

53. Information Governance Alliance. A Quick Guide to Sharing Patient Information for Urgent & Emergency Care (PDF 475KB). NHS England; 2015 [cited 2017 Sept 28].

54. Inokuchi R, Sato H, Nakamura K, Aoki Y, Shinohara K, Gunshin M, et al. Motivations and barriers to implementing electronic health records and ED information systems in Japan. Am J Emerg Med. 2014;32(7):725-30.

55. INPS. Emergency Care Summary User Guide (PDF 1.6MB) (Scotland). 2014 [cited 2017 Sept 28].

56. INSP. Key Information Summary Quick Reference Guide. July 2013 [cited 2017 Sept 28].

57. Johnson KB, Unertl KM, Chen Q, Lorenzi NM, Nian H, Bailey J, et al. Health information exchange usage in emergency departments and clinics: the who, what, and why. Journal of the American Medical Informatics Association. 2011;18(5):690-7.

58. Jones E. Are doctors in England making the best use of Summary Care Records? (PDF 363KB) 2016 [cited 2017 Sept 28]; Available from:.

59. Kennebeck SS, Timm N, Farrell MK, Spooner SA. Impact of electronic health record implementation on patient flow metrics in a pediatric emergency department. Journal of the American Medical Informatics Association. 2012;19(3):443-7.

60. Kierkegaard P. eHealth in Denmark: A Case Study. Journal of medical systems. 2013;37:9991.

61. Kierkegaard P. Interoperability after deployment: persistent challenges and regional strategies in Denmark. International Journal for Quality in Health Care. 2015;27(2):147-53.

62. Lammers EJ, Adler-Milstein J, Kocher KE. Does health information exchange reduce redundant imaging? Evidence from emergency departments. Med Care. 2014;52(3):227-34.

63. Lau F, Kuziemsky C. Handbook of eHealth evaluation: an evidence-based approach: University of Victoria; 2016.

64. Melvin CL, Saef SH, Pierce HO, Obeid JS, Carr CM. Health Information Exchange in the ED: What Do ED Clinicians Think? South Med J. 2016;109(7):419-26.

65. Menon AS, Greenwald S, Ma TJ, Kooshesh S, Duriseti R. Patient and physician willingness to use personal health records in the emergency department. Western Journal of Emergency Medicine. 2012;13(2):172-5.

66. Metro South Health. GP access to 'The Viewer'. 2017 [cited 2017 Sept 19].

67. Mohan MK, Bishop RO, Mallows JL. Effect of an electronic medical record information system on emergency department performance. Medical Journal of Australia. 2013;198(4):201-4.

68. National E-Health Transition Authority. My eHealth Record to National eHealth Record Transition Impact Evaluation: Phase 1 evaluation report (PDF 1.8MB). July 2015 [cited 2017 Sept 19].

69. National Health Service (NHS) choices. The Keogh Urgent and Emergency Care Review. 2016 [cited 2017 Sept 19].

70. National Health Service (NHS) Digital. Summary Care Record (SCR): The value of SCR in Urgent Care. 2015.

71. National Health Service (NHS) Wales. Welsh GP Record. [cited 2017 Sept 12]; Available from:.

72. National Health Service Digital (NHS Digital). Summary Care Records. [cited 2017 Sept 16].

73. Neri PM, Redden L, Poole S, Pozner CN, Horsky J, Raja AS, et al. Emergency medicine resident physicians' perceptions of electronic documentation and workflow: a mixed methods study. Applied clinical informatics. 2015;6(1):27-41.

74. Newfoundland and Labrador Centre for Health Information (NLCHI). Nova Scotia post implementation survey and interview results. 2014 [cited 2017 Oct 4].

75. Nguyen LB, E.; Nguyen, L.T. Electronic health records implementation: an evaluation of information system impact and contingency factors. International journal of medical informatics. 2014;83:779-96.

76. NHS. Next Steps on the NHS Five Year Forward View (PDF 1.7MB). March 2017 [cited 2017 Sept 28].

77. NHS Health Education England. Health Education England Strategic Framework 2014-2029 (PDF 10.5MB). February 2017 [cited 2017 Sept 28].

78. NHS Scotland. Key Information Summary Frequently Asked Questions For Patients (PDF 221KB). April 2013 [cited 2017 Sept 28].

79. NHS Scotland. eHealth Strategy 2014-2017 (PDF 689KB). March 2015 [cited 2017 Sept 28]; Available from:.

80. NHS Wales Informatics Service. Annual Review 2016: Delivering information and technology for better patient care (PDF 6.1MB). 2016 [cited 2017 Sept 28].

81. Northern Territory Government. Electronic health record: My eHealth Record. [cited 2017 Sept 19].

82. Nova Scotia. eHealth: SHARE (Secure Health Access Record). [cited 2017 Sept 24]; Available from:.

83. NSW Health. eHealth Strategy for NSW Health 2016–2026 (PDF 5.3MB). May 2016 [cited 2017 Sept 19].

84. Ozkaynak M, Dziadkowiec O, Mistry R, Callahan T, He Z, Deakyne S, et al. Characterizing workflow for pediatric asthma patients in emergency departments using electronic health records. Journal of biomedical informatics. 2015;57:386-98.

85. Palojoki S, Pajunen T, Saranto K, Lehtonen L. Electronic Health Record-Related Safety Concerns: A Cross-Sectional Survey of Electronic Health Record Users. JMIR medical informatics. 2016;4(2):e13. Epub 2016/05/08.

86. Park SY, Chen Y, Rudkin S. Technological and organizational adaptation of EMR implementation in an Emergency Department. ACM Transactions on Computer-Human Interaction. 2015;22(1):1-24.

87. Propp DA. Successful introduction of an emergency department electronic health record. Western Journal of Emergency Medicine: Integrating Emergency Care with Population Health. 2012;13(4):358-61.

88. Remen VM, Grimsmo A. Closing information gaps with shared electronic patient summaries: how much will it matter? International journal of medical informatics. 2011;80(11):775-81.

89. Risko N, Anderson D, Golden B, Wasil E, Barrueto F, Pimentel L, et al. The impact of electronic health record implementation on emergency physician efficiency and patient throughput. Healthcare. 2014;2(3):201-4.

90. SA Health. Enterprise Patient Administration System (EPAS): Frequently asked questions. 2017 [cited 2017 Sept 19].

91. Schanner A. EHR in Austria – regional and nationwide (PPT 2.2MB). 2008 [cited 2017 Sept 28].

92. Schweighofer E, Hötzendorfer W. Overview of the national laws on electronic health records in the EU member states. National Report for Austria (PDF 805KB). Milieu Ltd and Time.lex; March 2014 [cited 2017 Sept 28].

93. Scottish Clinical Information Management in Practice (SCIMP). The Scottish Emergency Care Summary: Improving unscheduled care (PDF 303KB). [cited 2017 Sept 14].

94. Scottish Clinical Information Management in Practice (SCIMP). The Scottish Emergency Care Summary: an evaluation of a national shared record system aiming to improve patient care (PDF 286KB). 2011 [cited 2017 Sept 14].

95. Shapiro JS, Crowley D, Hoxhaj S, Langabeer J, 2nd, Panik B, Taylor TB, et al. Health Information Exchange in Emergency Medicine. Annals of emergency medicine. 2016;67(2):216-26. Epub 2015/08/04.

96. Spetz J, Burgess JF, Phibbs CS. What Determines Successful Implementation of Inpatient Information Technology Systems? American Journal of Managed Care. 2012;18(3):157-62.

97. Sundhed.dk. National Health Record (Sundhedsjournalen) [translated in English].

98. Sundhed.dk. Shared Medication Card [translated in English]. [cited 2017 Sept 20].

99. Sundhed.dk. Your health portal. [cited 2017 Sept 19].

100. Unertl KM, Johnson KB, Lorenzi NM. Health information exchange technology on the front lines of healthcare: workflow factors and patterns of use. Journal of the American Medical Informatics Association. 2012;19(3):392-400.

101. Urgent and Emergency Care Review Programme Team. Transforming urgent and emergency care services in England: Clinical models for ambulance services (PDF 504KB). NHS England; November 2015 [cited 2017 Sept 28].

102. Urgent and Emergency Care Review Team, Emergency Care Intensive Support Team. Transforming urgent and emergency care services in England: A guide for local health and social care communities (PDF 1MB). NHS England; August 2015 [cited 2017 Sept 28]; Available from:.

103. Vest JR, Jasperson JS, Zhao H, Gamm LD, Ohsfeldt RL. Use of a health information exchange system in the emergency care of children. BMC Med Inf Decis Mak. 2011;11:78.

104. Victorian Department of Health and Human Services. Digitising health: How information and communications technology will enable person-centred health and wellbeing within Victoria (PDF 4.7MB). MelbourneAugust 2016 [cited 2017 Sept 19].

105. WA Department of Health. WA Health Information and Communications Technology (ICT) Strategy 2015–2018: Building a Strong Foundation (ASHX 1.2MB). 2015 [cited 2017 Sept 19].

106. Wachter R. Making IT Work: Harnessing the Power of Health Information Technology to Improve Care in England. National Advisory Group on Health Information Technology in England; September 2016 [cited 2017 Sept 28].

107. World Health Organization (WHO). Alphabetical list of the eHealth country profiles, 2015. 2015 [cited 2017 Sept 23]; Available from:.

108. World Health Organization (WHO). Atlas of eHealth country profiles (PDF 3.3MB). 2015 [cited 2017 Sept 23].

109. World Health Organization Regional Office for Americas. Handbook for electronic health records implementation (draft) (PDF 2.4MB). June 2017 [cited 2017 Sept 18].

110. World Health Organization Regional Office for Europe. Global eHealth survey 2015. 2015 [cited 2017 Sept 19].

7. Appendices

Appendix 1: Websites searched – grey literature review

International (general)

- Health Level Seven International (HL7)
- International Standards Organisation
- Organisation for Economic Cooperation and Development (OECD)
- Pan American Health Organisation
- SAI Global
- Special Interest Group on Computer Human Interaction (ACM SIGCHI)
- The Commonwealth Fund – International Healthcare System Profiles
- The Commonwealth Fund
- The International Medical Informatics Association (IMIA)
- World Health Organisation eHealth
- World Health Organisation Europe

Europe (general)

- European Commission - eHealth Strategies
- European Federation for Medical Informatics (EFMI)
- Integrating the Healthcare Enterprise (IHE Europe)

Austria

- Austria Public Health Portal (ELGA website)
- Federal Ministry of Health and Women

Canada

- Canada Health InfoCentral
- Canada Health Infoway
- Canada's Health Informatics Association (COACH)
- Canadian Association of Emergency Physicians (CAEP)
- Canadian Health Information Management Association (CHIMA)
- Canadian ICTC
- Canadian Nursing Informatics Association (CNIA)
- National Physician Survey (NPS)

Canadian Provinces and Territories

- Alberta
- British Columbia
- Manitoba
- New Brunswick
- Newfoundland & Labrador
- Northwest Territories
- Nova Scotia

- Nunavut
- Ontario
- Prince Edward Island
- Quebec
- Saskatchewan
- Yukon

Denmark

- Danish Emergency Management Agency
- Danish Ministry of Health
- Danish Regions
- Healthcare Denmark
- Sundhed.gk (“Health.dk”)

Denmark Regions

- Capital Region of Denmark
- Central Denmark Region
- North Denmark Region
- Region of Southern Denmark
- Region Zealand

United Kingdom

- British Computer Society Health (BCS Health)
- Scottish Clinical Information Management in Practice
- UK Council for Health Informatics Professions (UKCHIP)

NHS / Government websites

- Department of Health
- Health Education England
- NHS England
- eHealth Scotland
- NHS National Services Scotland
- Health & Social Care Services in Northern Ireland – eHealth and Care
- NHS Wales
- NHS Digital
- National Information Board

Ireland

- eHealth Ireland
- Healthcare Informatics Society of Ireland (HISI)
- Ireland Department of Health
- Ireland Health Information and Quality Authority

United States of America

- Agency for Healthcare Research and Quality

- American Institute of Healthcare Improvement

Japan

- Japan Healthcare Info
- Ministry of Health, Labour and Welfare

New Zealand

- Health Informatics New Zealand (HINZ)
- New Zealand Ministry of Health eHealth

Australia

- Agency for Clinical Innovation
- Australasian College for Emergency Medicine
- Australian Commission on Safety and Quality in Healthcare (ACSQHC)
- Australian Digital Health Agency
- Australian General Practice Network
- Australian Medical Association (AMA) (PDF 1.6MB)
- Health Informatics Society of Australia (HISA)
- National eHealth Transition Authority
- Royal Australian College of General Practitioners (RACGP)
- Standards Australia eHealth
- The Australasian College of Health Informatics (ACHI)
- The Australian Health Informatics Education Council (AHIEC)
- United General Practice Australia

Australian states and territories

- ACT Health
- Clinical Excellence Commission, NSW
- Department of Health NT
- Department of Health and Human Services, Victoria
- Department of Human Services, Tasmania
- NSW Bureau of Health Information
- NSW Ministry of Health
- eHealth NSW
- Queensland Health
- SA Health
- WA Health
- eHealthWA

Appendix 2: High-level and summary documents and data sets for EHR

Document / dataset	Description
The Commonwealth Fund International Healthcare System Profiles (May 2017)	This site presents overviews of the healthcare systems of Australia, Canada, China, Denmark, England, France, Germany, India, Israel, Italy, Japan, the Netherlands, New Zealand, Norway, Singapore, Sweden, Switzerland, Taiwan, and the United States. It is a companion document to the Commonwealth Fund's annual International Profiles of Healthcare Systems report and includes an overview of the status in relation to EHR implementation.
WHO Global eHealth survey 2015 and associated reports (see below)	This is the third global survey on eHealth conducted by the WHO Global Observatory for eHealth (GOe). In relation to EHR it explores the existence of national EHR systems, supporting legislation and barriers to implementation. A number of other reports draw on these results: • WHO Atlas of eHealth country profiles 2015 (PDF 3.3MB) • WHO European eHealth report 2016 (PDF 5.8MB) • WHO Global diffusion of eHealth 2016
WHO Atlas of eHealth country profiles 2015 (PDF 3.3MB)	This Atlas presents data collected on 125 WHO Member States. The survey was undertaken between April and August 2015 and represents the most current information on the use of eHealth in these countries. The Atlas will be a useful and unique reference tool for policy makers, eHealth planners and professionals.
WHO European eHealth report 2016 (PDF 5.8MB)	This report on the status of eHealth in the WHO European Region examines the results of the 2015 WHO global survey on eHealth to provide insight on how it is being used, major areas of development, perceived barriers to adoption and potential areas of growth
WHO Global diffusion of eHealth 2016	The report considers eHealth foundations built through policy development, funding approaches and capacity building in eHealth through the training of students and professionals. It then observes specific eHealth applications such as mHealth, telehealth, electronic health records systems and eLearning and how these contribute to the goals of UHC.
WHO Handbook for electronic health records implementation (draft) (PDF 2.4MB)	This document provides a guide for policy and decision makers addressing the most relevant challenges of implementing EHR at national or regional level. It addresses a wide range of issues applicable to implementation in general, but that will also apply to the emergency care setting.
European Commission Overview of the national laws on electronic health records in the EU Member States and their interaction with the provision of cross-border eHealth services (July 2014) (PDF 1.5MB)	This study provides an overview of the current national laws on EHRs in the EU Member States. It also addresses governance more broadly and is a useful summary of how the various systems have been developed and operate. Individual reports of participating member states are included on the site. The report also makes recommendations about processes such as consent, creation and updating of records, patient access, secondary use and archiving.

Document / dataset	Description
eSAC European countries on their journey towards national eHealth infrastructures (January 2011) (PDF 1.1MB)	The eHealth Strategies study and progress achieved with respect to national and regional eHealth solutions in EU and EEA Member States, with emphasis on barriers and enablers beyond tech structure elements and selected solutions emphasised in the European eHealth Action Plan of 2004.
OECD Strengthening health information infrastructure for healthcare quality governance: Good practices, new opportunities and data privacy protection challenges (April 2013) (PDF 2.6MB)	This OECD report describes the progress made in OECD countries to develop national health information infrastructure, describing good practices and opportunities. It focuses on two key dimensions: the development and linkage of health and healthcare data and the development and use of electronic health record systems, exploring the range of factors to be addressed for successful implementation.

Appendix 3: Electronic health records – Global overview

Table 5 provides an overview of the state of adoption of EHRs in 125 WHO member states.[108] Data is extracted from the findings of the 2015 WHO's Global Survey on eHealth.[110] The table below shows whether the country has introduced a national EHR system and if there is legislation governing its use. Complete country profiles are available on the WHO website.[107]

EHRs are defined in the report as:[108]

> Real-time, patient-centred records that provide immediate and secure information to authorised users. EHRs typically contain a patient's medical history, diagnoses and treatment, medications, allergies, immunisations, as well as radiology images and laboratory results. A National Electronic Health Records system is most-often implemented under the responsibility of the national health authority and will typically make a patient's medical history available to health professionals in healthcare institutions and provide linkages to related services such as pharmacies, laboratories, specialists, and emergency and medical imaging facilities.

Note: It is important to emphasise that the survey looked at national EHR systems, which are driven by national governments and publicly funded. Some Member States reported that their EHR systems did not fit fully within the definition and therefore were unable to have their EHR implementations recorded in the survey. Therefore the number of implementations may be underreported. To streamline questions and promote consistency, the survey used the terms EHRs and EMRs interchangeably although this is not strictly correct. EMRs are in-house electronic versions of the traditional paper charts that collect, store and display patient information and EHRs include additional information about the broader spectrum of health from all clinicians involved in an individual's care and can be shared electronically with other authorized health professionals.

Table 5: Global overview of national EHR systems[108]

	National EHR system		Legislation governing use of national EHR
Country	Country response (yes, no)	Year introduced	Country response (yes, no)
Afghanistan	n/a	n/a	n/a
Albania	Yes	2015	Yes
Algeria	No	n/a	n/a
Argentina	No	n/a	n/a
Armenia	No	n/a	n/a
Australia	Yes	2012	Yes
Austria	Yes	2015	Yes
Azerbaijan	Yes	2007	Yes
Bahrain	Yes	n/a	n/a
Bangladesh	No	n/a	n/a

Country	National EHR system		Legislation governing use of national EHR
	Country response (yes, no)	Year introduced	Country response (yes, no)
Belarus	Yes	2005	No
Belgium	Yes	2008	Yes
Benin	No	n/a	n/a
Bhutan	No	n/a	n/a
Bosnia and Herzegovina	Yes	n/a	Yes
Botswana	Yes	2004	No
Bulgaria	No	n/a	n/a
Burkina Faso	No	n/a	n/a
Burundi	No	n/a	n/a
Cabo Verde	Yes	2005	No
Cambodia	Yes	2011	No
Canada	Yes	2001	No
Central African Republic	No	n/a	n/a
Chile	Yes	2008	No
China	Yes	2009	No
Colombia	No	n/a	n/a
Comoros	No	n/a	n/a
Costa Rica	Yes	2011	Yes
Côte d'Ivoire	No	n/a	n/a
Croatia	No	n/a	n/a
Cuba	No	n/a	n/a
Cyprus	Yes	DNA	Yes
Czech Republic	No	n/a	n/a
Democratic People's Republic of Korea	No	n/a	n/a
Denmark	Yes	DNA	No
Dominican Republic	No	n/a	n/a
El Salvador	Yes	2009	n/a
Equatorial Guinea	No	n/a	n/a
Estonia	Yes	2007	Yes
Ethiopia	Yes	2008	Yes
Finland	Yes	2007	Yes
Gambia	No	n/a	n/a
Georgia	No	n/a	n/a

Country	National EHR system		Legislation governing use of national EHR
	Country response (yes, no)	Year introduced	Country response (yes, no)
Ghana	No	n/a	n/a
Greece	No	n/a	n/a
Guatemala	No	n/a	n/a
Guinea-Bissau	No	n/a	n/a
Honduras	No	n/a	n/a
Hungary	No	n/a	n/a
Iceland	Yes	2004	Yes
Iran (Islamic Republic of)	Yes	2002	Yes
Iraq	n/a	n/a	n/a
Ireland	No	n/a	n/a
Israel	Yes	2012	No
Italy	Yes	2012	Yes
Jamaica	Yes	2014	No
Japan	No	n/a	n/a
Jordan	Yes	2009	Yes
Kazakhstan	Yes	2003	No
Kenya	No	n/a	n/a
Kiribati	Yes	2012	n/a
Kyrgyzstan	No	n/a	n/a
Lao People's Democratic Republic	No	n/a	n/a
Latvia	No	n/a	n/a
Lebanon	No	n/a	n/a
Lesotho	Yes	1986	No
Lithuania	Yes	2011	Yes
Luxembourg	Yes	2015	Yes
Madagascar	No	n/a	n/a
Malawi	Yes	2009	No
Malaysia	Yes	2003	No
Maldives	No	n/a	n/a
Mali	No	n/a	n/a
Malta	No	n/a	n/a
Mauritania	No	n/a	n/a

Country	National EHR system		Legislation governing use of national EHR
	Country response (yes, no)	Year introduced	Country response (yes, no)
Mexico	Yes	2004	Yes
Mongolia	Yes	2004	Yes
Montenegro	Yes	2000	Yes
Morocco	No	n/a	n/a
Netherlands	No	n/a	n/a
New Zealand	No	n/a	n/a
Niger	No	n/a	n/a
Norway	Yes	1981	Yes
Oman	Yes	1997	Yes
Pakistan	Yes	2013	Yes
Panama	Yes	2012	No
Paraguay	Yes	2010	Yes
Peru	Yes	2015	Yes
Philippines	No	n/a	n/a
Poland	No	n/a	n/a
Portugal	Yes	2012	Yes
Qatar	No	n/a	n/a
Republic of Moldova	Yes	2014	No
Romania	Yes	2014	Yes
Russian Federation	Yes	2013	No
Rwanda	n/a	n/a	n/a
San Marino	Yes	1990	No
Senegal	No	n/a	n/a
Serbia	No	n/a	n/a
Seychelles	No	n/a	n/a
Singapore	Yes	2011	n/a
Slovenia	No	n/a	n/a
Somalia	No	n/a	n/a
South Africa	No	n/a	n/a
South Sudan	No	n/a	n/a
Spain	Yes	2009	n/a
Sudan	No	n/a	n/a
Sweden	No	n/a	n/a

Country	National EHR system		Legislation governing use of national EHR
	Country response (yes, no)	Year introduced	Country response (yes, no)
Switzerland	No	n/a	n/a
Syrian Arab Republic	No	n/a	n/a
Tajikistan	Yes	2013	No
Timor-Leste	Yes	n/a	No
Trinidad and Tobago	No	n/a	n/a
Tunisia	n/a	n/a	n/a
Turkey	Yes	2008	Yes
Turkmenistan	Yes	2010	Yes
Uganda	No	n/a	n/a
Ukraine	No	n/a	n/a
United Kingdom of Great Britain and Northern Ireland	No	n/a	n/a
United States of America	No	n/a	n/a
Uruguay	Yes	2014	n/a
Uzbekistan	Yes	2015	No
Vietnam	No	n/a	n/a
Zambia	Yes	2009	No
Zimbabwe	No	n/a	n/a

n/a = not applicable

Appendix 4: National EHR system features by jurisdiction

Process	**Feature**	**Country**						
		Australia	**Austria**	**Denmark**	**England**	**Northern Ireland**	**Scotland**	**Wales**
General	**EHR name; date introduced; main website**	• My Health Record • 2012	• ELGA (Elektronische Gesundheitsakte) • 2015	• Sundhedsjournalen (National Health Record) 2014	• Summary Care Record 2008	• Emergency Care Summary (ECS) – 2008 This is the GP summary. • Northern Ireland Electronic Care Record (NIECR) – 2013 This is the broader record / system providing access to data from a range of sources – see below.	• Emergency Care Summary (ECS) -2006 (no public access to main site) • Key Information Summary (KIS) -2013 • Palliative Care Summary (PCS) - 2009	• Welsh GP Record (2016) (formerly the Individual Health Record – 2005)
	Coverage (population with record)	• Approximately 21% of total population is registered (as of 14/9/17)	• Data not available	• 67% of individual healthcare providers use sundhed.dk portal through which the National Health Record is accessed	• 96% of people registered with a GP have a Summary Care Record (55 million records) (2016)	• 99% of 1.8 million population	• ECS - 99.9% of people registered with a GP have an ESC (5.1 million). • KIS – 2-3% have a KIS (generally for complex, chronically ill)	• 65% of 3 million
	Accessible in ED / urgent care settings	• Pilot only	• Public hospital roll out in 2015 (roll out in ED not specified)	• Public hospital roll out (from 2013) (roll out in ED not specified)	• Progressively from 2008	• 2008	• 2006	• National agreement for introduction to ED from 2009 (Individual Health Record)
Governance	**Overseeing agencies**	• Australian Digital Health Agency	• ELGA GmbH	• National eHealth Authority (NSI) • Regional eHealth Organisation (RSI)	• Managed by Data Coordination Board	• eHealth and Social Care Board	• eHealth Division NHS Scotland • Information Sharing Board	• NHS Wales Informatics Service • Wales Information

Process	Feature	Country						
		Australia	Austria	Denmark	England	Northern Ireland	Scotland	Wales
					- Implemented by NHS Digital (previously the Health and Social Care Information Centre)			Governance Board
	National eHealth and related strategies	- National Digital Health Strategy (2017)	- Austrian eHealth Strategy 2005 (PDF 1MB) - Austria ICT strategy (2015-2018) (in German)	- Strategy for Digital Welfare 2013-2020 (PDF 2.2MB) - Denmark eGovernment Digital Strategy 2016-2020	- Five Year Forward View (2014) and update - Personalised Health and Care 2020 (PDF 2.2MB) - Information and technology for better care: Our strategy for 2015-2020 (PDF 445KB) - Digital Strategy: Leading the Culture Change in Health and Care (2012) (PDF 296KB)	- eHealth and Care Strategy 2016	- National eHealth Strategy 2014-2017 (PDF 689KB) (and supporting eHealth Finance and eHealth Technical Strategies) - Digital Health and Social Care Strategy 2017-2022 is currently under development - Health and Social Care Information Sharing – A Strategic Framework 2014-2020 (PDF 550KB)	- Informed Health and Care – A Digital Health and Social Care Strategy for Wales 2015 (PDF 847KB)
	Legislation and data protection protocols* *not an exhaustive list	**Specific EHR legislation:** - My Health Records Act 2012 - My Health Records Rule 2016	**Specific EHR legislation (in German):** - ELGA Act 2013 (PDF 282KB) **Other legislations (in German)**	**Specific EHR legislation:** - None **Other legislations** - Act on Processing of Personal Data 2000	**Specific EHR legislation:** - None **Other legislation:** - Data Protection Act 1998	**Specific EHR legislation:** - None **Other legislation:** - Data Protection Act 1998 - Overview of governance and	**Specific EHR legislation:** - None **Other legislation:** - Data Protection Act 1998	**Specific EHR legislation:** - None **Other legislation:** - Data Protection Act 1998

Process	Feature	Country						
		Australia	**Austria**	**Denmark**	**England**	**Northern Ireland**	**Scotland**	**Wales**
		- My Health Records Regulation 2012 **Other legislation:** - Privacy Act 1988 - Healthcare Identifiers Act 2010 - Healthcare Identifiers Regulations 2010	- Data Protection Act (DSG 2000) (PDF 100KB) - eGovernment Act (PDF 659KB) - Overview of governance and law in Austria (PDF 705KB)	- Overview of governance and law in Denmark (PDF 701KB)	- Caldicott Principles (PDF 777KB) - Overview of governance and law in UK (PDF 1.1MB)	law in UK (PDF 1.1MB)	- Public Records Act (Scotland) 2011 - Overview of governance and law in UK (PDF 1.1MB) **Other protocols:** - Data Sharing Code of Practice (PDF 841KB) - Caldicott Principles (PDF 777KB)	- Freedom of Information Act **Other protocols:** - Caldicott Report - Wales Accord on Sharing of Personal Information (WASPI) - Overview of governance and law in UK (PDF 1.1MB)
	Unique patient identifier	- Individual Healthcare Identifier (IHI) - Everyone with a Medicare or Department of Veterans' Affairs (DVA) card has an IHI	- Citizen e-card or mobile phone signature based on their social security number	- Unique personal identifier (CPR); digital signature NEM-ID	- NHS number	- Health and Care Number	- Community Health Index (CGI)) - Each citizen can only be registered with one GP practice	- NHS number
System	**Structure**	**Centralised and decentralised model** - Health records are either uploaded into the National Repositories Service (NRS) or obtained from participating repositories (such as DHS operated repositories,	**Centralised and decentralised repositories** - ELGA contains a collection of links to data stored in decentralised repositories - Medication data are stored in encrypted form in a central repository. - Access to health data and	**Centralised repository** - The National Health Record is stored centrally and accessed via the Sundhed.dk portal - The information is collected from hospitals in all five Danish regions, as well as from GPs and other private practice healthcare provider.	**Centralised and decentralised model** - The Summary Care Record is stored on the Spine and accessible via the Spine portal which also hosts other shared services.	**Centralised and decentralised model** - The Emergency Care Summary is available as part of the NIECR accessible via the HSC secure network. NIECR also collects and links to information from other sources including	**Centralised rand decentralised model** - ECS and KIS are available on the central repository (ECS Store). accessible via local clinical portals in NHS regions through which clinicians access a range	**Centralised repository** - WGPR is available on the Welsh Care Records Service.

Process	Feature	Country						
		Australia	Austria	Denmark	England	Northern Ireland	Scotland	Wales
		diagnostic service providers, public health systems). • Access is via the Provider Portal for healthcare professionals and via the MyGov website for patients. • Some individual states have local portals through which the My Health Record is accessed.	medication is via the ELGA Portal.			hospital records, imaging, and pathology.	of other local and linked data.	
	Data source and updating	• Data is sourced from authorised healthcare provider systems (mainly primary care) which are uploaded to the NRS and participating repositories. • Data is also sourced from patients' own documents and notes uploaded to My Health Record. • Authorised healthcare providers can enter data	• Most data (except for medication data) are sourced from **hospitals, GP/ specialist** repositories and displayed as links on the ELGA portal. • Medication data is sourced from a central repository. • Only ELGA healthcare providers can create, host, access and update data.	• Data is sourced from **local hospital and GP/specialist EHR systems** and transferred to the central repository. • Only authorised healthcare professionals can create, host and access data. • Existing data can only be updated or edited by the healthcare provider who registered the data.	• **GP records** are the source of data for the SCR. • Data is automatically 'pulled' from the record when it is updated. • Data can only be updated at the GP practice. • Patients and other health providers cannot add to or change the SCR.	• **GP records** are the source of data for the Emergency Care Summary. • The timing of information extraction form GP records was not available. • Other data is drawn from hospital records, imaging, and pathology, as described above. • Information can also be recorded directly on the system (limited details	• **GP records** are the source of data for the ECS and KIS. • Data is 'pulled' from the record twice daily. • Data can only be updated at the GP practice. • There are local exceptions where, for example other health professionals can create or update the KIS without having access to the GP system.	• **GP records** are the source of data.

Process	Feature	Country						
		Australia	Austria	Denmark	England	Northern Ireland	Scotland	Wales
		using Conformant Clinical Software.				available about how this occurs) • Only authorised healthcare professionals can create, host and access data. • Patients cannot directly access or change the data.		
Content	**Scope**	• Health	• Health • Social care	• Health	• Health • Social care (in expanded record)	• Health	• ECS – Health • KIS – Health and social care	• Health
	Specific content	**My Health Record contains [Clinical documents]** – added by healthcare providers: • Shared Health Summary (created by the patient's 'nominated healthcare provider') – medical history, current medications, allergies, adverse reactions, immunisations) • Event Summaries – created by other providers	**ELGA currently contains:** • Laboratory data • Radiology data • Medications • Medical and nursing discharge letters from public hospitals **Planned content includes:** • Patient summary – overview of key health data (from primary care) • Vaccination and immunisation status • Outpatient reports	**National Health Record contains:** • Laboratory data • Imaging • Medications • Allergies • Vaccination records • Hospital notes and treatments – care summaries from hospitals • GP and other healthcare specialists – an overview of services received over time • Referrals – from healthcare professionals • Contact details of primary physician	**Summary Care Record core information:** • Demographics • Medications • Adverse reaction • Allergies **Expanded information (with patient consent)**: • Past and present medical history • Reason for medication • Anticipatory care information e.g. care of long term conditions	**Emergency Care Summary Record contains** • Demographics (name, DOB, gender, contact details) • Medication prescribed by GP • Allergies **NIECR contains** • Emergency Care Summary • Laboratory results • Imaging results • Investigation requests	**ECS contains**: • Demographics (name, DOB, CHI number, GP surgery • Medication prescribed by GP • Adverse reactions and allergies to medicines **KIS contains:** • Past medical history (High-priority read codes are automatically included) • Baseline functional and clinical status,	**Welsh GP Record contains:** • Demographic • Current medication and medication prescribed in the last two years • Allergies or any adverse reactions • Current problems or diagnosis • Results of tests in the previous year, for example, blood tests and x-rays

Process	Feature	Country						
		Australia	**Austria**	**Denmark**	**England**	**Northern Ireland**	**Scotland**	**Wales**
		(e.g. pharmacists, emergency department) • Hospital discharge summaries • Pathology and diagnostic imaging reports • Prescribed and dispensed medication • Specialist and referral documents **Medicare, PBS and PRBS information** **Organ donor decisions** **Immunisations** **Personal health notes** written by individual or an authorised representative: • Contact numbers and emergency contact details • Current medications • Allergy information and previous	• Pathology report • Imaging • Mother-child pass • Wills • Precautionary powers • Legal medical register	and other health professionals	• Communication preferences • End of life care • Immunisations **Exclusions:** Sensitive information like fertility treatments, sexually transmitted infections, pregnancy terminations and gender reassignment are not automatically included.	• Appointments • Encounter and discharge letters	including capacity • Triggers for deterioration • Current care needs and arrangements • Emergency contacts and next of kin details • How far to escalate care • Preferred place of care, and final care, other specific patient/carer wishes • Palliative care information • Legal issues such as power of attorney • DNACPR status • Special alerts – for example around staff safety	

Process	**Feature**	**Country**						
		Australia	**Austria**	**Denmark**	**England**	**Northern Ireland**	**Scotland**	**Wales**
		adverse reactions • Indigenous status • Veteran or ADF status • Advance care planning documents						
Client / patient participation & permissions	**Participation model**	**Record creation** • Presently voluntary **'opt-in'** system for creating the record. • The automatic creation of My Health Record (**opt out model**) for every Australian will begin from mid-2018. **Ongoing access** Patients can: • Hide any clinical data or Medicare documents and restore hidden documents. Once hidden, this information is not accessible, even in an emergency.	**Record creation** • Patients may opt out of ELGA totally. Patients can choose to opt-in at any time. • Patients can also opt out for certain components of the system (e.g. e-medication, e-reports) (situational opt-out) • Patients who have fully opted out and opted in again will start with a blank ELGA record; data previously saved in the system is deleted. **Ongoing access** Patients can: • Choose to opt-out of specific encounters or	**Record creation** • Authorised healthcare professional are under legal obligation to keep and update health records. Patient consent is not required to create the record; not allowed to refuse creation of health data. **Ongoing access** • Generally, patients' consent to treatment also implies consent for healthcare providers to access data necessary for treatment. • Patients have limited abilities to refuse access to health data in certain circumstances (details unclear)	**Record creation** • Patient may opt out of having a record created by GP. • Patient can choose to opt out at any time (by advising their GP). • Patient can also provide consent to enable more extensive information to be included in the record (as above). **Ongoing access** • Each clinician must obtain consent from the patient to access the record for each episode of care. • Exception is when the patient unable to consent in an	**Record creation** • Patient may opt out of having a record created by their GP. • Patient advises GP if they do not wish for ECR to be made available through NIECR. **Ongoing access** • Each clinician must obtain consent from the patient to access the record for each episode of care. • Consent in an emergency situation is not clear.	**ECS Record creation** • Patient may opt out of having a record created by their GP. • Patient can choose to opt out at any time. When this happens, all data including historic data is removed from ECS Store. **Ongoing access** • Each clinician must obtain consent from the patient to access the ECS record for each episode of care. • Exception is when the patient unable to consent in	**Record creation** • Patient may opt out of having a record created by their GP. • Patient can choose to opt out at any time. **Ongoing access** • Patient consent required every time the records are accessed

Process	Feature	Country						
		Australia	Austria	Denmark	England	Northern Ireland	Scotland	Wales
		• Control who accesses their information • Prevent other healthcare providers from accessing record unless in an emergency • Flag specific documents as 'limited access', and control who can view these documents Emergency access is granted without patients' consent if deemed necessary for treatment	during a specified timeframe (exception is when the patient unable to consent in an emergency situation). • Delete links to health data • Prevent access by a particular healthcare provider or institute to a particular piece or all of their data • Control duration of access. • For highly-sensitive encounters such as HIV infections, psychiatric treatment, genetic examinations, and abortions, the healthcare provider is obliged to inform the patient actively about their rights to request a situational opt-out.	**Emergency access** is however always granted if deemed necessary for treatment.	emergency situation.		an emergency situation. **KIS Record creation** • Patients opt in to the creation of a KIS record **Ongoing access** • Consent for viewing in secondary care is not required.	

Process	Feature	Country						
		Australia	Austria	Denmark	England	Northern Ireland	Scotland	Wales
	Patient access and contribution to data	• Patients can access via myGov account. • They can control health provider access to the record as described above. • They can contribute content as described above.	• **Patients can access**, view and download records once they have electronically identified themselves by a mobile phone signature or the citizen card/e-card. • Patients can delete links to health data and can prevent access by a particular healthcare provider or institute as described above. • Patients cannot change or contribute to the data.	• **Patients can access** and view records via sundhed.dk portal using their NEM-ID login. • Patient access to data is delayed (up to two weeks for hospital records; up to 45 days for GP/specialist consultations) to prevent coincidental access before communication of health status by the health professional. • Patients cannot contribute directly to the data.	• **Patient cannot directly access** the record but can request a copy from the GP. • They can request a change to the information if they think it is incorrect.	• **Patient cannot directly access** the ECR but can request a copy from the GP. • Request to the GP or Health Trust can be made to see the NIECR. The hospital or surgery has 40 days to respond to a request in writing.	• **Patient cannot directly access** the record but can request a copy from the GP. • They can request a change to the information if they think it is incorrect.	• **Patient access** to WGPR is intended to be available in 2017.
Access by health providers & data protection	**Health professional authorisation**	• Access only by healthcare providers registered with the HI Service (Healthcare Provider Identifier). AHPRA registered health professionals are automatically registered. and allocated	• Access only by authorised healthcare providers involved directly in patient care and treatment. • Authorised providers are registered with ELGA, called ELGA healthcare providers (ELGA-GDA).	• Access only by authorised healthcare providers involved directly in patient care and treatment. • Level of access restricted depending on role (Role Based Access Control).	• Access only by authorised health service staff. • Access restricted depending on role e.g. clinical versus non-clinical (Role Based Access Control).	• Access only by authorised HSC staff involved in provision of care. • Detail of authorisation process not available.	• Available only to those involved directly in care. • **ECS** was initially restricted to authorised health service providers in out of hours medical centres, NHS 24, hospital emergency departments	• Hospital doctors and nurses directly involved in care. • Doctors and nurses working in the GP out of hours service and directly involved in care. • Hospital pharmacists

Process	Feature	Country						
		Australia	Austria	Denmark	England	Northern Ireland	Scotland	Wales
		Healthcare Provider Identifier for Individuals (HPI-I). Other providers required to apply for an HPI-I. • Only healthcare providers involved in the patient's care can access a patient's My Health Record. • The My Health Record healthcare provider individual's registration process.					but since expanded to ambulance, hospital pharmacists, hospices and secondary care users. • Security protocol requires that users only access information relevant to their role but this is not enforced by the system.	and pharmacy technicians directly involved in care. • In the future community-based pharmacists, emergency services first responder and advanced paramedics directly involved in person's care, will also have access to Welsh GP Record.
	Health service authorisation	• Access only by healthcare providers registered with the HI Service. • My Health Record healthcare provider organisation's registration process	• Access only by authorised healthcare services involved directly in patient care and treatment. • Authorised institutions / providers are registered with ELGA, called ELGA healthcare providers (ELGA-GDA)	• Separate authorisation process for health services not specified	• Access only by authorised health services.	• Separate authorisation process for health services not specified	• Access only by authorised health services. • Initially restricted to out of hours medical centres, NHS 24, hospital emergency departments but expanding, as above. • As above, users can access using a facility within that patient's	• Separate authorisation process for health services not specified

Process	Feature	Country						
		Australia	Austria	Denmark	England	Northern Ireland	Scotland	Wales
							record in their own clinical system or portal. Boards will register all users and have processes in place to control role based access, ensure that clinicians access ECS/KIS appropriately and audit users.	
	Access process	• A National Authentication Service for Health (NASH) Public Key Infrastructure (PKI) Certificate is a digital certificate that authenticates an individual provider or organisation whenever they access the My Health Record system • Healthcare providers have two methods to access My Health Record: via conformant clinical software which connects to and interacts	• Access by healthcare providers is through the **ELGA portal.** • Validation and proof of treatment relationship is required (e.g. by scanning the patient's citizen card/e-card). • Default duration of access = 28 days after proof of treatment (e.g. inserting of ecard and healthcare provider card in the office); pharmacies can only access ELGA for 2 hours.	• Access by healthcare providers is through the **Sundhed.dk portal.** • Patients' consent to treatment also implies consent for healthcare providers to access data necessary for treatment. • There are different rules for identification and authentication which are dependent on regional EHR systems (controlled via local data controller in accordance	• Access is via **the Spine** portal using a NHS smartcard and passcode	• Access via secure **HSC network portal.** • Patient consent required every time the records are accessed • Regular audits are made of who has accessed the record (no technical data about how this is conducted).	• Access via local clinical portals in NHS regions. • Can usually be accessed via interface with user's main system so that multiple passwords not required.	• Access requires user name and password

Process	Feature	Country						
		Australia	Austria	Denmark	England	Northern Ireland	Scotland	Wales
		with the My Health Record system; and through the National Provider Portal (read-only via the internet browser).						
	Data protection strategies	• System records and reports all instances of data access. This is shown in the healthcare identifier history. • Education and awareness programs which highlight the need for individuals to protect themselves against security threats, hoaxes and scamming activities. • Monitoring access to My Health Records and the My Health Record system to quickly detect suspicious or inappropriate behaviour. • Rigorous, on-going security	• System records and reports all instances of data access which is available to patients.	• System records and reports all instances of data access which is available to patients. • Bi-annual audit is conducted where a random sample of log files are checked for irregularities.	• System records and reports all instances of data access. • Each time an SCR is viewed, an alert will be generated on a system database called the alert viewer. Future plans include enabling direct access to such alerts / records by patients. Presently a report can be requested by the patient. • There is auditing of these records to identify breaches. • There is mandatory training for authorised health professionals regarding data	• Data access is audited (no specific details provided).	• The ECS Store keeps an audit trail of all successful and attempted accesses to ECS records. • GPs can access ECS Store and review the audit trail for the records of patients registered with their practice. • Auditing is also conducted by health boards as above. • A record is kept of all access. • GP surgery can check who accesses record • Health Boards also audit.	**National Intelligent Integrated Audit System (NIIAS)** • NIIAS keeps a log of every access to a patient's medical record and who looked at the record. The system integrates with a wide range of existing electronic health record systems to produce a range of automatically generated reports, instantly highlighting any potential issues if access has not been for the legitimate

Process	Feature	Country						
		Australia	Austria	Denmark	England	Northern Ireland	Scotland	Wales
		testing, including penetration testing. - Australian Health Digital Agency security and authentication			protection responsibilities. - System includes screen reminders regarding data protection.			care of the patient.

AUSTRALIAN COMMISSION
ON SAFETY AND QUALITY IN HEALTH CARE
Level 5, 255 Elizabeth Street, Sydney NSW 2000
GPO Box 5480, Sydney NSW 2001
Phone: (02) 9126 3600
Fax: (02) 9126 3613
Email: mail@safetyandquality.gov.au
Website: www.safetyandquality.gov.au