Rapid Review

NORTH AMERICAN OBSERVATORY on Health Systems and Policies

Adopting EMRs and Information Technology in Primary Care

A Rapid Review Prepared for the Yukon Government

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Introduction and Background

Electronic medical records (EMR) and the use of information or related technologies have become increasingly relevant to support provider-to-peer communication and improve care coordination (Manca, 2015). EMRs and health information systems are considered to be among the building blocks of a high-performing health system (Kruse, Stein, Thomas, & Kaur, 2018; Marchildon & Hutchison, 2016; Romanow, 2002). In addition, they are increasingly common within medical practices, primary among family physicians (Menachemi, Perkins, van Durme, & Brooks, 2006; Peckham, Ho, & Marchildon, 2018; Peckham, Kreindler, Church, Chatwood, & Marchildon, 2018; Whitacre, 2017).

A recent rapid review exploring how primary care reform has progressed in Canadian jurisdictions over the last decade highlighted that the Northwest Territories is the only region to have jurisdiction-wide communication. Northwest Territories, through the enterprise territorial EMR system, has 100 percent of the primary care providers participating (Peckham, Kreindler, et al., 2018). However, presently no Canadian jurisdiction offers information sharing among patients/caregivers and providers.

Given that EMRs and related information technologies are a large component of high-performing healthcare systems and there remains very little progress towards territorial, provincial, or national EMR systems, this rapid review seeks to understand the outcomes associated with EMR use, the barriers towards implementation, and strategies for encouraging adoption.

This review also highlights jurisdictions where EMRs have been adopted and summarizes lessons learned for successful implementation and uptake among primary care providers. Although the original intention of the review was to specifically explore the implementation of EMRs in rural and remote areas, we found little evidence specific to this population. Consequently, this rapid review draws on the broader primary care EMR literature and considers transferable implications for rural areas.

Methods

This rapid review was conducted to understand the best practices for adopting and/or using electronic medical records (EMR) and health information technology (HIT) in primary care settings.

Rapid Scoping Review

Two iterations of the search strategy were developed and executed to explore EMR use in primary care. The first specifically sought to identify primary care EMR use among rural, remote, or underserved populations. After executing a search and screening the titles ad abstracts of pertinent articles, it became clear that there was limited review literature evidence specific to rural populations. Consequently, we broadened the search to explore primary care EMR use more generally.

The final search strategy was developed to identify relevant review articles in three health sciences databases: MEDLINE, EMBASE, and CINAHL Plus (Appendix A). A combination of subject headings and textwords were generated and tested in MEDLINE and applied to the other two databases. We searched for articles that included two key concepts: 1) primary care, and 2) electronic medical records. To broaden the search, we also targeted specific professions understood to frequently operate within primary care, such as general practitioners, nurse practitioners, nurses, and physician assistants. EMRs and IT were focused in the search to ensure that these technologies were the primary focus of the articles retrieved. Searches were limited to review articles published in English between 2017 and 2019.[1]

All articles retrieved through the search strategy were imported into Zotero referencing software and duplicates were removed. Titles and abstracts were reviewed by two researchers (RN, AK) and marked as 'include', 'exclude', or 'uncertain'. A third researcher (SC) was consulted to discuss and help resolve uncertainties. Once initial screening was completed, two researchers (RN, AK) screened the full texts of selected articles. Any uncertainties during full-text screening were discussed amongst the team until a consensus was reached regarding inclusion. A total of 23 articles were included by meeting the following criteria: a) published review articles (i.e., systematic reviews, scoping reviews, integrated reviews, etc.); and b) discussed the uptake or use of EMRs or IT in primary care settings. Articles that focused exclusively on low- and middle-income settings and articles without full-text versions available were excluded. The full study selection process is depicted in detail in Appendix B (Moher, Liberati, Tetzlaff, & Altman, 2009).

Three researchers charted data from the articles into a standardized data extraction form (RN, MK, AK) (Appendix C). This form was first piloted by the researchers using three articles to ensure that the data extraction process was consistent, and any challenges with the form were discussed within the team. Team meetings were held to discuss preliminary findings and provide descriptive summaries and analysis. Three researchers (AK, RN, SC) then analyzed the completed data extraction form and the original publications to identify important themes and inconsistencies between the articles.

[1] Search filters developed by McMaster University's Health Information Research Unit (2016) were used to identify review articles in MEDLINE and EMBASE. These filters were adapted to retrieve review articles in CINAHL.

Rapid Jurisdictional Review

The literature scoping review was supplemented with brief reviews of three jurisdictions of interest – namely, Sweden, the United States (Intermountain Health Care System), and Australia – to identify existing EMR initiatives in primary care, as well as best practices and impacts, if available. The jurisdictional reviews involved a broad scan of grey literature (e.g., government and independent evaluation reports), government websites, media releases, and websites of other relevant international bodies (e.g., European Observatory on Health Systems & Policies, OECD, & The World Bank).

Limitations of this review

- The literature review includes only recently published secondary sources (i.e., review articles), and therefore may miss potentially relevant primary and grey literature sources, as well as articles published prior to 2017.
- The studies included in each of the reviews varied in quality; assessment of quality was outside the scope of this review.
- The jurisdictional review was selective; we did not capture all promising EMR initiatives in the three jurisdictions included in this study.

Analytic Overview

Objectives of the Reviews

The reviews discussed EMR use in primary care in a variety of ways. The most commonly cited review objectives centered around the potential impact of EMR use on health-related, provider-related, and process-related outcomes. For example, two reviews reported on the impact of EMR implementation on the workload of healthcare providers (Baumann, Baker, & Elshaug, 2018; Wisner, Lyndon, & Chesla, 2019), and a third considered the multiple workarounds providers developed in response to EMR implementation (Patterson, 2018). The impact of health technologies or EMRs on specific health outcomes was also reported in several reviews. Specifically, these reviews explored the relationship between EMRs and the use of unscheduled care (Bowden & Coiera, 2017), care coordination (Falconer, Kho, & Docherty, 2018), chronic disease management (Kooij et al., 2017), continuity of care (Wu & LaRue, 2017), and population health (Kruse et al., 2018). Finally, three reviews reported the impact of EMRs on health care processes, specifically: 1) laboratory testing (Maillet et al., 2018), 2) medication reconciliation (Marien, Krug, & Spinewine, 2017), and 3) patient-provider communication (Rathert, Mittler, Banerjee, & McDaniel, 2017).

Rather than exploring impact, four reviews focused primarily on the design of primary care EMRs. One of these reviews discussed different types of EMR data structures and then assessed how they influenced providers' work (Forsvik et al., 2017). A second review focused specifically on information visualizations, a more modern feature often included in EMRs to visually present health information to patients and providers (Lor, Koleck, & Bakken, 2019). Two reviews discussed reporting on primary care data and EMR inclusion of data on the social determinants of health (Gentil et al., 2017; Venzon, Le, & Kim, 2019).

Another common objective of the reviews considered EMR utilization or uptake. One review focused on various interventions to improve EMR use among providers (Hamade, Terry, & Malvankar-Mehta, 2019), another on the different ways to measure EMR use (Huang, Gibson, & Terry, 2018), and a third looked to see how EMRs could be used in different health care settings. These settings included nursing homes (Ko, Wagner, & Spetz, 2018), long-term care facilities (Kruse et al., 2017), and chiropractic practices (Taylor, 2017).

Two reviews focused specifically on stakeholder attitudes towards the adoption of EMRs. One of these reviews explored womens', caregivers', and providers' experiences with home-based records, some of which were electronically based (Magwood et al., 2018). The other review reported on primary care physicians' attitudes towards EMR (O'Donnell, Kaner, Shaw, & Haighton, 2018).

It is important to note that despite the stated primary objectives of the reviews, some considered more than one of the above described elements within their analyses.

Outcomes Associated with EMRs

This rapid review sought to discern the outcomes associated with EMR use in primary care settings. Six outcomes were commonly described among the reviews, namely: 1) satisfaction, 2) reduced institutionalization, 3) costs, 4) general health outcomes, 5) quality of care, and 6) access to, and quality of, health information. Below we present a summary of the available information.

Satisfaction

There was mixed evidence across the reviews to suggest that EMR technologies had an impact on patient or provider satisfaction. Several reviews reported limited or weak evidence demonstrating improved satisfaction among patients or providers as a result of EMR use (Kruse et al., 2017, 2018; Maillet et al., 2018; Rathert et al., 2017). One review did not report specifically on satisfaction as a result of EMRs, but found that electronic communications applications were associated with higher satisfaction among primary care providers (Kooij et al., 2017). Two reviews reported mixed patient or provider satisfaction with EMRs (Falconer et al., 2018; Ko et al., 2018). In one of these reviews, high satisfaction with EMRs was reported in relation to billing, scheduling, and communication functions; however, there was poor satisfaction with screening for mental illness (Falconer et al., 2018). Notably, two reviews found that inadequate or inappropriate training was associated with decreased provider satisfaction with EMRs (Ko et al., 2018; Taylor, 2017). Ultimately, these mixed findings suggest that there are likely opportunities to improve both patient and provider EMR experience, with current systems offering a mix of positive and negative aspects.

Institutionalization

Three review articles reported that health information technologies had a positive effect on reducing hospitalization and hospital readmissions (Bowden & Coiera, 2017; Kash, Baek, Davis, Champagne-Langabeer, & Langabeer, 2017; Kooij et al., 2017). Two of the reviews noted a decline in readmission rates and rehospitalization rates in association with EMR use specifically (Bowden & Coiera, 2017; Kooij et al., 2017). The third review considered various health information exchange interventions that involved sharing health information electronically, and concluded that the most successful interventions at reducing hospitalization demonstrated collaboration between specialists and primary care providers to enhance transitions of care (Kash et al., 2017). No review found a negative association between EMR use and rates of institutionalization.

Costs

This rapid review identified limited evidence to suggest that EMRs had a significant positive effect on individual or health system costs. Only two of the reviews explicitly reported on cost as an outcome of health information technology interventions, and both concluded that there was insufficient evidence to support the idea of widespread economic benefits (Bowden & Coiera, 2017; Kash et al., 2017). Other review articles seemed to support the idea that EMRs could produce cost savings; however, did not provide empirical evidence (Baumann et al., 2018; Wu & LaRue, 2017). Despite the lack of evidence in support of cost savings, it remains possible that EMR technologies could offer long-term financial returns. For example, Baumann et al. (2018) suggested that EMRs offer an opportunity to shift documentation tasks towards administrative professionals, thus reducing hospital costs. However, further research is required to evaluate these types of long-term cost savings in relation to the costs associated with

implementing the technology.

General health outcomes

The literature identified improvements for a variety of disease-related outcomes. The ability to share clinical information between primary and specialty care led to positive effects on clinical outcomes for diabetes patients, including improvements in their glycated hemoglobin (HbA1c), BMI, LDL, and cholesterol (Kooij et al., 2017). In particular, electronic decision support tools led to changes in several markers of cardiovascular health, including increased physical activity and decreased body mass index, low density lipoprotein, systolic blood pressure, and smoking cessation (Kooij et al., 2017). A systematic review evaluating the influence of EMRs on outcomes in long-term care facilities also identified improvements in infection occurrence, high-risk pressure sores, neurolepsis, functional capacity, range of motion, and medication administration (Kruse et al., 2017).

Access to health information and information quality

EMRs have the capacity to not only provide easier access to medical information, but also to improve the quality of information. EMRs facilitated real-time availability and remote access to patient records (Kruse et al., 2017). They may offer faster turnaround times, improve traceability of test results, and help avoid results going missing; yet, clinicians may not interpret results any faster than they previously would have despite adoption of EMRs (Maillet et al., 2018).

EMRs appeared to improve the accuracy, organization, and presentation of patient data. Audit-and-feedback processes, prompts to double-check information, and the use of structured data are features that have been identified to improve data quality (Rathert et al., 2017; Forsvik et al., 2016). Data quality is not only critical for accuracy and completeness, but it also leads to significant increases in EMR use in primary care, as identified by Hamade et al. (2019). The improved accuracy and precision associated with EMR data was also indicated as a facilitator of EMR adoption (Kruse et al., 2018). However, Wisner et al. (2019) noted that the cognitive challenges (e.g., large volumes of data, fragmented and scattered data, etc.) sometimes associated with EMR use may lead to decreased documentation accuracy, and comprehension and interpretation of data.

Quality-of-care and care coordination

In addition to improved data quality, there is reason to believe that EMR adoption may also lead to better quality-of-care. EMRs have been shown to improve care quality, both directly and indirectly through improved interprofessional integration (Kruse et al., 2017). Physicians agreed that the potential benefit of EMRs on care quality outweighs the potential benefits of cost savings; yet, the authors attested that longitudinal studies and retrospective reviews are required for further confirmation (Wu & LaRue et al., 2017). There is mixed evidence regarding the influence of specific elements of EMRs, such as electronic medication reconciliation tools, on quality-of-care (Marien et al., 2017). In long-term care settings, staff perceived that health information technology improved communication and documentation, but there was a lack of evidence that it increases quality (Marien et al., 2017). Therefore, more evidence is needed to establish that EMRs improve care in other settings and for specific tasks.

Several studies highlighted EMRs' ability to improve the coordination of care (Hamade et al., 2019; Wisner et al., 2019; Kash et al., 2017); however, Wisner et al. (2019) indicated that the increased use of

EMRs and electronic communication does not inherently improve communication and understanding among physicians.

Barriers to EMR Uptake

Our analysis of the review literature revealed several barriers towards the full adoption and integration of EMRs in primary care. These barriers were grouped broadly into five themes: 1) time, 2) usability, 3) cost, 4) privacy, and 5) technical structure. These barriers are described in detail below.

Time

Time constraints imposed by EMRs were perceived to be a significant barrier towards the complete adoption and efficient use of information technologies in primary care. Despite common conceptions that EMRs would improve health providers' workflow, multiple reviews described potentially mixed or negative effects of EMRs on providers' workloads due to the effort and time required to document and find relevant information (Baumann et al., 2018; Falconer et al., 2018; Ko et al., 2018; Kruse et al., 2017, 2018; Maillet et al., 2018; O'Donnell et al., 2018; Rathert et al., 2017; Taylor, 2017; Wisner et al., 2019). For example, Wisner, Lyndon, & Chesla (2019) found that entering, retrieving, understanding, and synthesizing EMR information was perceived as difficult and increased nurses' cognitive workloads. Similarly, another review on chiropractors' adoption of EMRs found that some technical features of the system resulted in an unnecessary volume of information that negatively impacted their review-time efficiency (Taylor, 2017).

Concerns over time and productivity loss were especially apparent when there was an incomplete uptake of EMRs into routine practice. In particular, several reviews noted how such partial uptake could result in fragmented or duplicate documentation, thus increasing providers' workloads (Baumann et al., 2018; Falconer et al., 2018; Ko et al., 2018; Maillet et al., 2018). Importantly, the time constraints imposed by adopting a new EMR system are not only borne by providers, and one review also described potential productivity loss among those responsible for teaching users how to use the EMR and enter data correctly (Kruse et al., 2018). Consequently, time spent mastering the system represented an important challenge for many stakeholders when considering and implementing EMRs.

Usability

The overall usability or utility of EMRs was frequently described as a barrier towards achieving full uptake of the tool in primary care settings (Kruse et al., 2017; Maillet et al., 2018; O'Donnell et al., 2018). The successful adoption of EMRs can require a steep learning curve (Falconer et al., 2018), for which there was often perceived to be inadequate training and preparation (Ko et al., 2018; Taylor, 2017). The reviews also described challenges associated with the structure of the EMRs, which did not match providers' thought or work processes (Wisner et al., 2019), presented missing, inadequate, or redundant data (Kruse et al., 2018; Wisner et al., 2019; Wu & LaRue, 2017), were difficult to navigate (Falconer et al., 2018), or lacked important features (Falconer et al., 2018; Hamade et al., 2019; Patterson, 2018; Wu & LaRue, 2017). For example, one study reported the importance of EMRs including a summary overview display, as well as communication features like flags, warnings, and reminders (Patterson, 2018). These limitations in EMR technology could result in problematic practices, including a number of discretionary workarounds adopted by providers to mitigate the challenges imposed by EMRs (Patterson, 2018). For example, in

some cases staff developed paper-based or whiteboard systems to share information, thus circumventing the EMR system.

An important driver for adopting EMR use is its potential for interoperability among providers and settings; however, according to some reviews this feature represented a potential barrier to adoption. For example, one found that a lack of interoperability between primary care EMRs and secondary care information technology systems influenced physicians' attitudes towards EMR adoption (O'Donnell et al., 2018). Similarly, another found that data could not be easily shared between providers in some cases due to a lack of standards for interoperability (Kruse et al., 2018). As such, usability and user-friendliness of the EMR technologies were frequently reported in the reviews as potential barriers to uptake, with reported limitations in the technology itself, and a lack of adequate training support for end-users.

Technical

Broader challenges at the technical and network level were also perceived to limit the adoption of EMRs. In the reviews, a variety of technical issues were described as potential barriers to EMR adoption, including: technical failures (Ko et al., 2018; Maillet et al., 2018), wireless connectivity issues (Ko et al., 2018), accessibility and user problems (Bowden & Coiera, 2017; Maillet et al., 2018; O'Donnell et al., 2018), and network and connectivity issues (Maillet et al., 2018). These types of technical issues served to decrease the reliability and usability of the technology in practice. At a health system level, there were also perceived issues with the compatibility of different EMR softwares. As two reviews pointed out, regions without a single standardized EMR system can create limitations on data sharing, reducing the utility of the tool (Gentil et al., 2017; Venzon et al., 2019). For example, Gentil et al. (2017) highlighted how in France, more than 12 EMR software applications with often incompatible data schemas are used, making it difficult to create a nation-wide primary care data collection network.

Cost

Unsurprisingly, the costs associated with adopting new EMR platforms were described as organizational and end-user barriers in several reviews. Four reviews pointed specifically to high upfront costs as creating challenges towards the adoption of new information technology system in various primary care settings (Falconer et al., 2018; O'Donnell et al., 2018; Taylor, 2017; Wu & LaRue, 2017). Once a technology had been adopted, ongoing funding and sustainability represented barriers at the organizational level (O'Donnell et al., 2018; Wu & LaRue, 2017). Finally, three reviews pointed out that a lack of financial incentives or reimbursements may limit end-user uptake of the technology (Hamade et al., 2019; O'Donnell et al., 2018; Wu & LaRue, 2017). These types of financial constraints associated with investing in EMRs were also anticipated to disproportionately impact rural areas that often have limited access to the devices and networks required to support them (Falconer et al., 2018).

Privacy

Concerns over the privacy and confidentiality of the EMR technology also presented a barrier to adoption. These concerns appeared to manifest in two different ways among patients and providers. First, several reviews reported concerns with the privacy and confidentiality of the EMRs themselves (Falconer et al., 2018; Magwood et al., 2018; Rathert et al., 2017). These concerns may have been associated with the technological nature of the records, as one review found that confidentiality was only expressed as a concern when home-based records were stored electronically (Magwood et al., 2018). Second, several

reviews described concerns associated with the sharing of patients' personal health information between providers and settings (Kash et al., 2017; O'Donnell et al., 2018; Wu & LaRue, 2017). These reviews suggested that the full integration of EMRs and other information technologies would continue to face challenges until these concerns were addressed.

Strategies to Encourage EMR Adoption

In addition to the barriers described above, our assessment of the literature identified a range of recommendations that could be used to enhance EMR adoption in primary care. Common recommendations included: 1) engaging organizations and end-users in EMR planning and implementation; 2) ensuring that EMRs are fully integrated into practices and systems; 3) implementing design features aimed at improving EMR usability; 4) providing ongoing training and support to EMR users; 5) utilizing financial support and incentives as a lever to mobilize adoption; and 6) undertaking evaluations of EMR technologies to better understand use.

Engage organizations and end-users

Organization and end-user engagement is integral to the successful adoption of EMRs in primary care. As O'Donnell et al. (2018) aptly concluded: "policymakers and system architects designing such initiatives need to recognize that EMR programmes are complex interventions, which must be implemented in dynamic social-technical systems, but that adoption is ultimately determined by the attitudes and preferences of the individual clinician." As such, in order to fully advance the implementation of EMRs into routine practice, various community engagement strategies must be in place (Kash et al., 2017). Particularly important for the future uptake of EMRs is the inclusion of stakeholder perceptions during the development and implementation process to ensure that the technology will meet their future needs of users (Ko et al., 2018; Magwood et al., 2018; O'Donnell et al., 2018). Engaging providers and other stakeholders in this process can be facilitated through the endorsements of clinical leaders and EMR champions (Marien et al., 2017; O'Donnell et al., 2018). Certain approaches to implementing EMRs, in particular "middle-out" approaches that encourage the information technology industry to work directly with the healthcare system, also appear to be associated with increased engagement and implementation success (Bowden & Coiera, 2017). In combination, these and other strategies to engage stakeholders, for example in the use of financial levers (i.e., paying physicians to adopt EMR technologies in their practice), are expected to encourage EMR adoption.

Fully integrate EMRs into practices and systems

The successful adoption of EMRs also appears to be associated with the extent to which the technology is integrated into provider practices and the healthcare system. As previously described, several reviews suggested that provider workflow was hindered when EMRs were not fully integrated, and providers were forced to document care in multiple places (Baumann et al., 2018; Falconer et al., 2018; Ko et al., 2018; Maillet et al., 2018). This suggests that fully integrating the EMR platform and replacing paper recording may improve the efficiency of providers' documentation processes, thus encouraging adoption. Similarly, integrating EMRs at the health system level, by ensuring software and data compatibility across sites, is anticipated to improve uptake (Kash et al., 2017; Kruse et al., 2018).

Design features to support EMR use

Determining what design features are necessary to support providers and encourage the use of EMRs was seen to be of critical importance. This could be accomplished through extensive usability and pilot testing before implementing or updating the technology (Marien et al., 2017). Design features used to support communication between different stakeholders were described as important in some reviews (Patterson, 2018; Rathert et al., 2017). Examples of communication features could include: screen sharing to explain test results to patients (Maillet et al., 2018), or patient portals that supported secure messaging (Rathert et al., 2017). Ensuring that a full record or summary overview of the patient's information was also reported as an important feature of EMRs (Bowden & Coiera, 2017; Patterson, 2018). Similarly, customizing EMR displays for different health professions or encounters could also serve to increase their utility for providers (Taylor, 2017; Wu & LaRue, 2017). One review also recommended that policymakers invest in different add-on features, such as clinician decision support systems and customized referral templates, to improve EMR use (Hamade et al., 2019).

Three reviews commented specifically on how the documentation structure of EMRs could facilitate or limit their use among providers (Forsvik et al., 2017; Venzon et al., 2019; Wisner et al., 2019). Structured data fields were anticipated to improve the completeness of data, efficiency of reporting, and transferability of information (Forsvik et al., 2017; Venzon et al., 2019; Wisner et al., 2019). Conversely, narrative data fields that permitted more description were sometimes preferred by clinicians and were potentially more useful than structured data for reporting on thought processes and uncertainties (Forsvik et al., 2017). These findings suggest that a blend of both structured and narrative data fields might be optimal for supporting EMR use.

Provide ongoing training and support

Training and continuing support during and after implementation of EMRs can also improve uptake. Prior to implementing or adapting EMRs, Ko et al. (2018) recommended conducting a readiness and technical needs assessment to determine the informational needs of staff. Once EMRs have been implemented, ongoing training and opportunities to practice using the technology should be made available (Hamade et al., 2019; Ko et al., 2018; Kruse et al., 2018; Marien et al., 2017; O'Donnell et al., 2018; Wu & LaRue, 2017). One review reported that a process of auditing and providing feedback to users also led to greater adoption (O'Donnell et al., 2018). Similarly, access to information and support from non-clinical staff could improve uptake (Ko et al., 2018; Wu & LaRue, 2017). Finally, providers informational needs could be supported through the adoption of policies or guidelines on the proper use of different health technologies (Marien et al., 2017; O'Donnell et al., 2018).

Consider financial support and incentives

Financial support for organizations and providers were frequently described among the facilitators for EMR adoption (Falconer et al., 2018; Gentil et al., 2017; Hamade et al., 2019; Ko et al., 2018; Kruse et al., 2017; O'Donnell et al., 2018; Taylor, 2017). Financial incentives may be particularly important to offset the adoption costs associated with the technology (Kruse et al., 2017). For example, one review recommended increasing the adoption of EMRs through federal initiatives that offered additional assistance to community health centres (Falconer et al., 2018). However, despite review authors' frequent recommendation to offer financial incentive, such incentives should not be expected to improve adoption

rates alone. In particular, O'Donnell et al. (2018) recommended caution towards relying on financial incentive programs, as they did not uniformly improve adoption rates across the included studies.

Undertake meaningful evaluations

Although not described in direct relation to improving EMR adoption in the reviews, comprehensive evaluations of EMR programs could indirectly influence future uptake. An existing challenge to improving EMR uptake is the at present limited ability to measure their meaningful use. This can make it difficult to identify appropriate interventions and strategically increase uptake among providers. In response to this, two authors recommended developing clearly defined methods or frameworks for assessing EMR use across jurisdictions (Hamade et al., 2019; Huang et al., 2018). These types of tools could help improve our understanding of EMR use and target specific gaps in adoption patterns. More sophisticated evaluations of EMR use might also serve to identify underlying problems with the technologies themselves. For example, Bowden and Coiera (2017) expressed concern over the lack of theory underpinning EMR design and evaluation, and suggested that this may indicate that the EMRs were "generic technology driven endeavours". Given the importance of usability and user engagement for EMR uptake, these evaluations might be useful in distinguishing between potentially successful and inappropriate EMR design.

Jurisdictional Review

Sweden

Sweden provides a strong case for innovation in terms of EMR utility. Since the Swedish healthcare structure is decentralized in nature, various county councils and municipalities use different EMR systems throughout the country (Philips, 2017). As well, due to the Primary Care Choice Reform, there are both private and public providers of primary healthcare. While it might be assumed that these factors raise barriers to sharing patient information, two innovations allow patient information to be shared across providers and to patients. These tools include a national health exchange platform that allows EMR information to be combined into a single database and national patient portal that allows patients to access their own health records.

The Health Information Exchange

The Health Information Exchange (HIE) is the Sweden's national platform to facilitate communication between different health information systems and eHealth services (Philips, 2017). This platform provides a single point of connectivity for the various EMR systems that exist, making it appear as if there was a national EMR system. Currently, 19 of the 21 regions are connected to the platform, meaning that most patient information in Sweden is on the platform (Maria, Jonas, Rose-Mharie, & Isabella, 2018). Patient perceptions of the platform are much more positive than those of healthcare professionals, the latter of whom still have concerns about the system and its usability (Moll et al., 2018). The implementation of this database has required a shift in the perspectives of healthcare providers, requiring them to be more open in terms of providing direct access to care and provision, and ultimately to embrace this change that supports the national aim of ensuring patients have immediate access to their personal healthcare records. The HIE feeds into the national patient portal, which in turn securely provides patients with access to their healthcare records.

Journalen

Journalen is the eHealth patient record site that is accessed through the national patient portal called 1177.se (Philips, 2017). Through the general site, users can search information about illnesses, symptoms, treatments, and healthcare in a particular region. As well, users can find and compare health clinics, use e-services to contact healthcare providers, manage (request, cancel, or reschedule) appointments, and refill prescriptions. The Journalen function of the site allows users to view all electronic health data in one place, even if it has been recorded on multiple EMR systems. The results of this project so far demonstrate that 41% of citizens have created an account on the portal to access their health data. As well, a national survey found that patients are responding positively to the tool and feel that they are more informed, have improved communication with medical staff, and have a better understanding of their health status (Philips, 2017). Healthcare professionals, however, have been less enthusiastic about patients using this tool. Their main concern is that patients are accessing test results and other important information before they are able to speak to a patient in person, potentially causing a lack of understanding or over-worrying for the patient. To address this concern, many healthcare professionals are implementing a two-week waiting period to allow healthcare professionals to inform a patient of their results prior to their having access to this information on their healthcare record (Maria et al., 2018).

Intermountain Healthcare (Utah, United States)

The healthcare system in the United States is a hybrid of publicly and privately run programs (DPE Research Department, 2016). The majority of insured Americans are covered through their employers, and government-funded programs, such as Medicaid and Medicare, provide coverage to some vulnerable populations (i.e., low-income citizens, those living with a disability, or older adults) (DPE Research Department, 2016).

Adoption of EMRs in the United States has increased steadily, partly in response to federal incentives (Adler-Milstein et al., 2017). In 2015, approximately 81% of hospitals had adopted at least a basic EMR system (Adler-Milstein et al., 2017), and similar trends have been noted for outpatient clinics and primary care offices (Myrick, Ogburn, & Ward, 2019). However, the adoption of more advanced EMR functions has lagged behind, as has uptake in rural and small hospitals across the country (Adler-Milstein et al., 2015). Therefore, while EMR adoption is increasing overall, there remain barriers associated with advanced use, resources, and up-front and ongoing costs.

Intermountain Healthcare (IHC) is a non-profit healthcare system in the United States and the largest provider of healthcare in the state of Utah. IHC was established in 1975 when the Latter-Day Saints Church donated 15 hospitals under the premise that the IHC runs as a charitable, non-profit, secular organization caring for the people of Intermountain West (Baker et al., 2008). Today, IHC manages 24 hospitals, 2,400 physicians and advance practice providers, 160 clinics, and 38,000 employees working in Utah, Wyoming, and Idaho (Intermountain Healthcare, n.d.-a). It offers its own health insurance plan, SelectHealth, that covers approximately 850,000 individuals (Baker et al., 2008).

IHC has a reputation for clinical excellence. It has been recognized for its integration, information systems, clinical care, and financial performance. Its foundation in evidence-based medicine and quality improvement has shown positive advancements in patient outcomes and costs, as highlighted in the following interventions (Baker et al., 2008).

iCentra

IHC was the first hospital system in the United States to develop an EMR system (Baker et al., 2008). Its newest system, iCentra, was launched in 2017 and developed in collaboration with Cerner (an American health information technology supplier). iCentra is an integrated electronic health record, practice management, and revenue cycle system for all IHC hospitals and medical facilities. The EMR is also accessible for patients, family members, and providers, with the capacity for online visits and secure messaging for monitoring and communication (Intermountain Healthcare, n.d.-b).

iCentra provides greater efficiency in collecting and accessing patient information, easier coordination and transition of care, and less duplicate testing, imaging, and paper processing (Intermountain Healthcare, n.d.-b). The new system also enables organizations to identify and track medical costs, services, and outcomes specific to particular care processes; for instance, the EMR links patient data with clinical and financial outcomes that are presented to the individual physician in real time (Conn, 2015; Intermountain Healthcare, 2017). iCentra also incorporates IHC's Care Process Models, which provide best practice guidelines and workflow tools embedded in the EMR (Cerner Corporation, 2015).

Case studies at IHC have demonstrated that interventions involving iCentra improve care quality and save costs (Ott & Olsen, 2019). For example, the EMR at IHC was redesigned with the goal of reducing the amount and number of red blood cell (RBC) transfusions. Education, timely and repetitive feedback of each physician's personal transfusion practices, and an automated data tracking and ordering system was implemented. Within a three-year period, the percentage of patients receiving RBC transfusions decreased by 30% in addition to millions in cost savings and decreased 30-day mortality rates (Ott & Olsen, 2019).

The implementation of iCentra required robust testing, learning, and training with clinical teams. Clinicians were offered resources, including videos and a "wiki" page, and mandatory courses a year prior to the launch (Intermountain Healthcare, 2016). Larger LCD screens were deployed to suit the wide-angle layout of iCentra, in addition to further updates for PC computers (Intermountain Healthcare, 2016). Teams of "super users" involving physician coaches, informaticists, and clinical leaders were developed during the launch to provide support with the transition (Intermountain Healthcare, n.d.-b).

Care Process Models

Care Process Models (CPM) are best practice guidelines and digital workflow tools incorporated into iCentra. Each model is created by IHC's Patient and Provider Publications department in collaboration with teams of physicians, nurses, and administrators with clinical and operations experience (Intermountain Healthcare, 2017).

CPMs provide algorithmic and measurable actions that can be incorporated into workflows, as well as clinical, financial, and service outcomes that can be linked to any variations in processes (Intermountain Healthcare, 2017). A learning feedback loop is formed whereby the EMR data from every patient treated by CPMs is used to improve the next application of the CPM. In addition, CPMs are updated at least every two years to reflect any changes in guidelines (Intermountain Healthcare, 2017).

CPMs guide physicians toward clinical decisions that improve outcomes for patients. CPMs provide for quicker and more effective implementation of new best practices and standardize the approach and measurement of core clinical processes (Intermountain Healthcare, 2017). Evidence for the benefit of CPMs has been identified across the literature, demonstrating increased efficiencies, improvements in disease-related outcomes, and reduced costs (Byington et al., 2012; Nkoy et al., 2015; Patel et al., 2017). However, there are several barriers to note, including inconsistent alignment of CPMs with the priorities and needs of staff, clinician skepticism, the complexity of the models, and lack of standards for implementation.

There are a number of individuals involved to support the development and implementation of CPMs. Patient viewpoints and experiences are sought out to help make the models clinically meaningful and applicable in practice (Intermountain Healthcare, 2017). A data analyst is involved in each CPM to ensure it meets iCentra data strategies and goals. Implementation is further supported by clinical champions, process champions, and medical writers (Intermountain Healthcare, 2017).

Australia

Australia is a federation, with fiscal and functional responsibilities divided between the Australian Government and the six states and two territories. The Australian healthcare system (Medicare) is publicly financed primarily through taxation and a compulsory health insurance levy. The federal government is responsible for health policymaking and funding, while state health departments oversee health service delivery. Primary care practitioners act as referral gatekeepers to the rest of the healthcare system, as they constitute the first point of medical contact (Healy, Sharman, & Lokuge, 2006).

In July 2012, the federal Department of Health and Ageing launched a national electronic health record system, My Health Record (formerly the Personally Controlled Electronic Health Record, PCEHR) – a secure online platform that can be accessed by both patients and their authorized healthcare providers. In response to an early evaluation of the program, My Health Record underwent a major reform in 2018, which significantly increased uptake, but also raised some privacy concerns. As independent long-term evaluations of My Health Record are not yet available, we outline the My Health Record implementation process, regulation, and reform in the subsequent section.

My Health Record

My Health Record allows providers involved in a person's care to upload, view, and download the following documents: Shared Health Summary (overview of medications, diagnoses, and treatments), individual event summaries, discharge summaries, specialist letters, referrals, and prescription and medication dispense records from pharmacies. An e-referral system is available to facilitate provider communication and patient management. Patients may also keep private health diaries in the system and a mobile application is available to track child development (Department of Health and Ageing, 2013).

Despite its decentralized healthcare delivery system, Australia's eHealth infrastructure is governed at the federal level. The legal framework for My Health Record was set out by the 2012 PCEHR Act, which established a set of legal protections to ensure personal health information confidentiality. These include personal control over which healthcare providers may access an individual's health record, narrow and closely defined limits on circumstances in which information may be accessed outside of these controls, availability of an audit trail of all access to a person's record, civil penalties for unauthorized access, and requirements to report data breaches. In addition to legal protections, technical security features include patient ability to remove access for certain documents in their record (which may be overridden in emergency situations), patient ability to remove individual documents from their record, receipt of notifications when the record is being accessed by others, and ability to view an audit log. Finally, national eHealth capability and funding are governed by a set of contracts, agreements, and memoranda of understanding between the Department of Human Services, the National E-Health Transition Authority (NEHTA), the Office of the Australian Information Commissioner, the Department of Veterans' Affairs, and the Australian Commission on Safety and Quality in Health Care (Department of Health and Ageing, 2013).

All individuals covered by Australia's publicly funded healthcare system, and thus assigned an Individual Healthcare Identifier (IHI), are eligible to have a My Health Record (Department of Human Services, 2018). Upon its launch in 2012, registration for a My Health Record operated on an "opt-in" basis. This meant that patients could voluntarily register for a record either online, by mail, by phone, or in person.

Healthcare providers were encouraged to talk to their patients about the advantages of having an electronic health record and facilitate registration. The first-year evaluation of My Health Record by the Australian Government revealed that approximately only 400,000 individuals registered for a record, with 58% of these registrations facilitated through healthcare providers (Department of Health and Ageing, 2013). The Australian Government concluded that a system overhaul was necessary to improve uptake (Siggins Miller, 2016).

In 2015, the Australian Government commissioned an independent evaluation of an "opt-out" strategy pilot at two sites – Northern Queensland and Nepean Blue Mountains. In contrast to the opt-in strategy, the opt-out strategy involved automatically creating a My Health Record for every eligible Australian with an IHI and having a one-year period during which individuals could opt-out. The opt-out pilot was accompanied by mapping of digital health and readiness of healthcare providers, public-facing education and promotion activities, and consultations with vulnerable and hard-to-reach populations. The independent evaluation concluded that the opt-out strategy was superior in acceptability and uptake among patients and healthcare providers; consequently, a recommendation was made to nationalize the strategy (Siggins Miller, 2016).

The opt-out strategy was nationalized in 2018. Following the conclusion of the opt-out period in January 2019, 9 out of 10 Australians were reported to have a My Health Record (i.e., national opt-out rate of 10%). Individuals that initially chose to opt out are still able to create a My Health Record at any point, while those with a record are likewise able to request its deletion (Australian Digital Health Agency, 2019). Although some privacy concerns were raised in the media regarding the automatic creation of an online health record for all Australians (Smee, 2018), the independent pre-implementation evaluation showed that once the My Health Record system was explained, most patients thought that its benefits outweighed the risks (Siggins Miller, 2016). In focus groups, having a positive view of the My Health Record platform was consistent across different patient demographic groups, including people from culturally and linguistically diverse backgrounds, Aboriginal and Torres Strait Islander populations, as well as people with varying levels of computer literacy and computer or internet access. Patients also mentioned that they preferred having a record created for them with the choice of opting out, rather than having to actively register or opt in. Interestingly, many assumed that their health information was already being electronically shared between their healthcare providers, even before the nation-wide roll-out of My Health Record (Siggins Miller, 2016).

Conclusions

This report summarizes review literature on the use of EMRs in primary care and offers a series of considerations for implementing the technology in high-income settings.

The review literature provided some evidence to suggest that the adoption of EMRs was associated with a range of positive health, process, and system outcomes. Among the reviews, a small body of evidence suggested that the adoption of EMRs had a positive impact on institutionalization rates and general health outcomes. There was also some evidence that EMRs could produce cost-savings; however, few comprehensive economic evaluations of the technology were available. More frequently, review authors reported positive outcomes pertaining to the quality-of-care and healthcare data. Our jurisdictional review of Sweden, Intermountain Healthcare in the United States, and Australia revealed similar outcomes associated with EMR use. In particular, the adoption of EMRs seemed to result in improved health outcomes, patient satisfaction and knowledge, and reduced health systems costs.

A variety of barriers towards EMR adoption were reported among the reviews. Most frequently, the utility and user-friendliness of the technology were perceived to impact uptake. Utility was also negatively influenced by various technical and network barriers described across different EMR platforms. The time required to plan, learn, adopt, and use EMRs was also a deterrent towards implementation. Finally, concerns over the high costs of implementing the program, and privacy and confidentiality issues stemming from sharing health information online, were also reported as barriers.

These concerns were echoed in the jurisdictional reviews, and various approaches were undertaken to mitigate their effects. In both Sweden and the United States, providers expressed ongoing concerns with the adoption of EMRs, largely as a consequence of their perceptions regarding the utility and usability of the technology. Various strategies had been employed to improve the utility of the tool, including delayed information sharing with patients and the provision of guidelines and workflow tools. In Intermountain Healthcare, provider training and EMR champions were also important for encouraging uptake. Our review of Australia's My Health Record system specifically identified privacy and confidentiality concerns with regard to EMR use. To address these issues, several different strategies were employed to increase transparency and give patients greater control over the tool. These strategies included the implementation of audit trails and user privileges allowing patients to remove files from their EMRs.

In this review of the published literature, we also identified a range of strategies that could be used to improve EMR uptake in primary care. These include:

1. **Engage organizations and end users** in the planning, development, and implementation of EMR technologies to ensure that the tool will properly address their needs.
2. **Fully integrate EMRs** into the practices of providers and to services across organizations, in order to reduce unnecessary administrative burden and maximize the utility of the tool.
3. Utilize stakeholder feedback on **design features and add-ons** that will encourage their use of the technology.

4. Provide **ongoing training and support** to ensure that end-users are comfortable with the tool and have resources in place to respond to inquiries.
5. Consider utilizing **financial support or incentives** to encourage providers and organizations to invest in the technology.
6. Conduct **meaningful evaluations** of the EMR tool and its use, to better understand adoption patterns, associated outcomes, and the strengths and limitations of the tool.

Although these strategies were discussed in relation to broad populations in the review articles, they are also transferable to rural populations. Engaging organizations and end-users and providing financial support may be particularly important in rural settings to ensure that the EMR system is culturally appropriate and feasible given the resources that are available.

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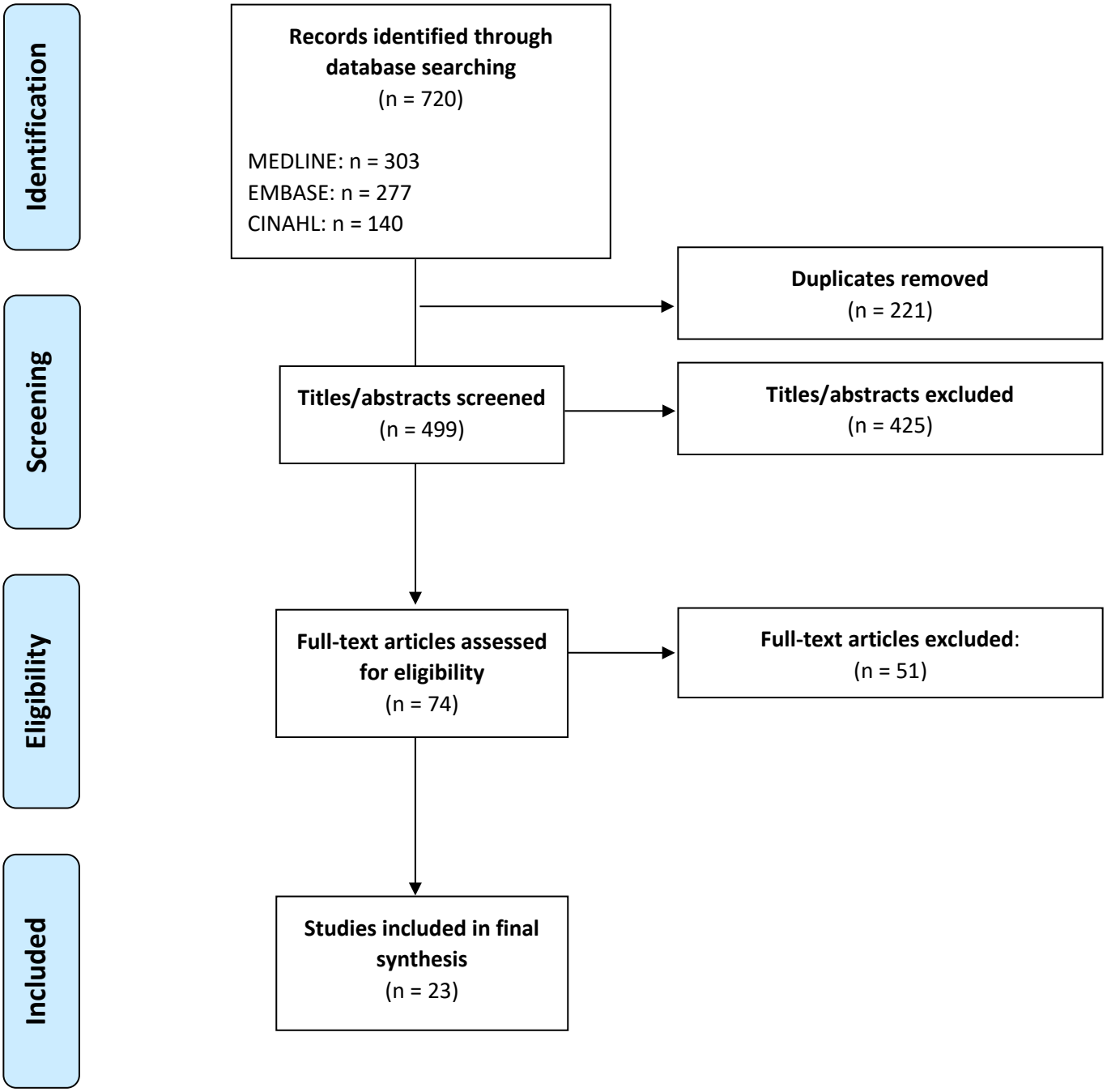
Appendix A: Search Strategy

1	exp Primary Health Care/
2	exp Patient Care Team/
3	exp Family Practice/
4	exp General Practice/
5	exp Physicians, Family/
6	exp Nurse Practitioners/
7	exp Nurses/
8	exp Physician Assistants/
9	primary health care.tw,kf.
10	primary care.tw,kf.
11	(primary care adj4 (model or models or practice or practices or team or teams or network or networks)).tw,kf.
12	((family health or family medicine) adj4 (team or teams or network or networks or model or models or practice or practices)).tw,kf.
13	family medicine.tw,kf.
14	(general practice or general practitioner or general practitioners).tw,kf.
15	(nurs* or registered nurse or registered nurses or nurse practitioner or nurse practitioners).tw,kf.
16	(nurse led or nurse-led).tw,kf.
17	(physician assistant or physician assistants).tw,kf.
18	(first adj4 (care or contact)).tw,kf.
19	1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16 or 17 or 18
20	exp *Electronic Health Records/
21	exp *Medical Records Systems, Computerized/
22	exp *Information Technology/
23	exp *Medical Informatics/
24	(electronic health record or electronic health records or electronic medical record or electronic medical records).tw,kf.
25	((health record or medical record) adj4 (electronic or computer or digital or mobile)).tw,kf.
26	(health informatic* or medical informatic* or information technolog*).tw,kf.
27	20 or 21 or 22 or 23 or 24 or 25 or 26
28	meta analysis.mp,pt. or review.pt. or search:.tw.
29	19 and 27 and 28
1	exp Primary Health Care/
2	exp Patient Care Team/
3	exp Family Practice/
4	exp General Practice/
5	exp Physicians, Family/
6	exp Nurse Practitioners/
7	exp Nurses/
8	exp Physician Assistants/
9	primary health care.tw,kf.
10	primary care.tw,kf.
11	(primary care adj4 (model or models or practice or practices or team or teams or network or networks)).tw,kf.

Appendix B: PRISMA diagram



Adapted from: Moher, D., Liberati, A., Tetzlaff, J. & Altman, D.G., The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. *PLoS Medicine* 6(7): e1000097. doi:10.1371/journal.pmed1000097

Appendix C: Summary of the Review Literature

Author/ Year	Target Population (Jurisdiction)	Method & Outcomes of Interest	Intervention/ Component Type	Summary of Key Findings	Author Recommendations
Baumann et al. (2018)	Hospital staff (physicians, nurses, interns) (Australia, Austria, Canada, Denmark, France, Germany, Greece, United States [US], United Kingdom [UK])	Method: Systematic review (28 studies: 17 pre-electronic medical record (EMR), 9 post-EMR, 2 pre- and post-EMR) Outcomes of Interest: Adaptation to EMR, efficiency of EMR documentation, multitasking, and/or interruptions	Implementation of EMR system; Documentation and/or charting as electronic record by clinicians for: quality improvement/ efficiency/time reduction/error reduction/ improved patient outcomes/ improved time allocation	Adaptation to EMR: increase in proportion of staff time spend on documentations after introduction of system; mixed results on impact on time spent on direct care of patients and care planning by nurses and physicians. (+/-) Efficiency of EMR documentation: Several studies noted inefficiencies in the use of an electronic health record system. Even after implementation, significant use was still made of paper documentation. Lack of centralized care overview across hospitals with EMR systems. Documentation was fragmented since nurses still inclined to make paper notes. (-) Multitasking and interruptions: Before implementation of an EMR, daily workload of hospital staff was additionally impacted by high interruption rate and frequency of multitasking. Nearly 50% of the time, nurses were found to spend their working time performing direct care, indirect care, personal, or unit-related activities simultaneously. Few studies measured direct comparisons between pre- and post-implementation of EMR. However, one study found a decrease in multitasking time from 21% to 9% of working time after full implementation. (+W)	EMR systems may ultimately improve work and information flow. Great variation is noted, likely to be due to differences between countries, so more studies need to be evaluated to determine both inter- and intra-system traits. EMR system implementation may lead to inefficiencies; however, after an initial transition phase, exclusive utilization of electronic records rather than paper records could potentially lead to a more efficient system, allowing for improved information flow between different disciplines and medical institutions and more time for direct patient care and communication. Multitasking and interruptions may adversely affect patient safety, thus the presence of an electronic health record system may be beneficial in reducing multitasking. Delegation of certain documentation tasks to administrative staff may also reduce time pressure on clinicians, as well as alleviate the need to multitask thereby reducing hospital costs.

Bowden & Coiera (2017)	Patients receiving unscheduled care (Great Britain, Scotland, England, USA, Netherlands, Isreal)	Method: Systematic review (22 articles) Outcomes of Interest: System aspects, health outcomes, costs, usability/reliability, implementation approach	Shared electronic health records (SEHRs) Intervention of interest was unscheduled care, but majority of studies included pertained to primary care	Improved quality and safety of care: None of the studies quantitatively measured impact of SEHR on quality or safety of care. One study also noted that it is difficult to prove specific clinical benefits due to ethical considerations. One Israeli study reported that access to an SEHR improved admission planning for cardiac patients through reduction of number of avoidable single-day admissions by 17.3%. (|, +/-) Economic impact: No system-wide economic benefit analyses were reported. However, a 52% reduction in laboratory tests and 36% reduction in radiology examinations ordered per patient at a single emergency department as a consequence of accessing patient data from a health information exchange was found. Asides this, studies did not calculate financial savings. (|) System usability and reliability: Unreliability of system or interruption to access because of problems with a computer network were seen as key reasons for clinicians not accessing the SEHR. Several technical designs, such as reducing number of keystrokes, removing toggle between interfaces, and reliability presenting data were all seen as ways in which usage could be encouraged. (|) Implementation approach: English National Programme for Information Technology (NPfIT) top-down program delivery encounters technical and clinical end-user challenges, where current English strategy has stronger user engagement and involvement in system procurement. (|)	Authors are surprised that these large-scale programs requiring huge investments to design, build, and implement are not based on strong prior evidence, and would have at least triggered evaluation of system benefits post-implementation. Authors stress the urgent need for better evaluation studies concerning safety, quality, and outcomes. When implementing a shared record system, maximizing utilization should be a focus. This can be done by focusing on clinical needs and work practices. This would result in minimizing barriers to SEHR access and maximizing clinical value of information retrieved. Middle-out programs (less-direct, emphasizing development of interoperability standards and encourage IT industry to work directly with healthcare system) appear more likely to engage stakeholders and ultimately succeed. Considering SEHR as part of an information value chain emphasizes that information delivery must be connected to decision making and will help deliver the most value.

Falconer et al. (2018)	Individuals receiving mental health care	Method: Systematic review (21 articles) Outcomes of Interest: Patient outcomes	Electronic health records (EHRs) for care coordination/ integrated care/collaborative care/patient registries/ population health management	Barriers found: EHRs generally lack features essential to support key shared care plan templates for behavioral and primary care integration. Duplicate documentation can occur if care goes beyond primary care. EHRs present initial time consumption, steep learning curves, and difficult to navigate templated notes. Lack of chronic illness registries and confidentiality concerns presented. There is poor satisfaction (unspecified if provider or patient) with screening for mental illness. (-) Identified advantages of using EHRs included: shared access of patient information between providers, high satisfaction with billing/scheduling/ screening/interdisciplinary communication for mental health, long-term efficiency and a more complete record, EHRs brought more value to interdisciplinary communication. (+)	Increased and faster adoption of health information technology (HIT) like EHRs can be facilitated by federal initiatives and added financial assistance to community health centers. Though there are many positive findings in collaborative care models, there are limited studies referring to new digital technologies to coordinate care for patients with mental health conditions. Authors do not give direct recommendations regarding the implementation of EMRs.
Forsvik et al. (2016)	Clinicians (Canada, US, Germany, Finland, Netherlands, UK, Norway, Hong Kong, New Zealand)	Method: Literature review (40 articles) Outcomes of Interest: Evaluation of structured data	EHR and data structures (New data entry forms, fully automated natural language processing, diagnostic coding, problem lists)	Structured data is faster to enter, easy to process and makes work processes easier. But studies suggest that coding and entering structured data is slower for the user and overall, clinicians prefer free text data entry. (+/-) Structured data was found to be more complete than narrative text. However, the completeness was usually defined by verifying whether certain pre-defined data items existed; and this definition does not exclude the possibility that narratives would contain more clinically relevant information than structured data. (|) There were no studies which measured improvements in care outcomes due to improved completeness of data. (|)	Structured data is often more useful and more complete than unstructured data. Free narrative text is strongest in applications where descriptions of thought processes or expressions of uncertainty and probabilities are required. The gap between narrative text and structured data may be bridged by using natural language processing algorithms which enable processing the text with classifiers or indexers. Small and trivial interventions may have significant impacts on the outcomes or flow of care processes. Examples of simple but effective interventions are common document

				There was a single study which did not find significant improvement in information completeness when narrative text was replaced by a form. (=) The subjective user experience is an important part of usability. Studies show that individual differences in clinical decision-making processes between users are significant. (+)	naming schemes and division of a document under predefined sections.
Gentil et al. (2017)	No specific target population specified (Australia, Belgium, Canada, France, Italy, Malta, Netherlands, Spain, Sweden, Switzerland, UK, US)	Method: Systematic review (36 data collection networks) Outcomes of Interest: Factors and facilitators of development of durability of routine primary car data collection	Primary care data collection projects; Technical features, General practitioner (GP)'s contribution, network managers	In most cases, a data warehouse was linked to an official administration that brought the added value of official recognition. (+) Functional integrated platforms facilitate data exploitation by providing networks that extract datasets from the data warehouse for researchers and by offering a range of services and products in the areas of medical research and public health care. (+) Software companies play a key role directly via their software system and the development of data extracting tools. Data must be processed and integrated before being released to final users, generally academic researchers.	A local network effect can occur and facilitate the spreading of primary care data collection projects. GPs can be promoted to increase their contribution to project by demonstrating the advantages they can get in return such as financial benefits, training sessions, regular feedback, and participation in research programs. Three main actors remain important in supporting initiatives include governmental services, academic institutions and software companies. Participation of GPs also act as a facilitator to these projects.
Hamade et al. (2019)	Healthcare workers and managers, including physicians, nurses, and medical assistants (US, UK, Finland, Canada, Ireland)	Method: Systematic review (12 articles) Outcomes of Interest: Measurements of use of EMR functions (number of uses, duration of use), outcomes affected by EMR use (number of referrals and completeness of patient records)	Interventions to improve EMR use; Professional interventions, organizational interventions, and financial interventions directed at the use of EMR functions and data quality	The predominant intervention type identified in this review used educational material, seminars and guidelines to target EMR use (professional interventions). Personal, organizational, and financial interventions directed at the use of EMR functions and directed at data quality have a significant and favourable effect on improving EMR use. Interventions targeted at the use of EMR functions were five times more likely to show improvements in EMR use compared with	Overall, policymakers are encouraged to invest in EMR feature add-ons (such as clinical decision support systems and customized referral templates), educational materials, and financial incentives targeted at improving EMR use. Perceived barriers to EMR use include lack of both financial incentives and useful EMR features. To address perceived barriers, the implementation of financial and organizational

				controls. Interventions directed at data quality improved EMR use by five and a half times more than the controls. (+) Professional interventions include educational material for data recording/quality, focus group feedback, educations sessions, seminars, and guidelines. Organizational interventions include web-based appraisal tools, EMR add-ons (e.g., "look up button"), and computer-based decision support systems (reminders pertaining to treatment triggered by diagnostic data).Financial interventions included financial incentives for physicians to reach certain levels of quality scores. (+) Outcomes achieved by EMRs: organization of patient healthcare information, improving coordination of care, easier electronic access to medical information, and expert opinion.	interventions is required. Financial interventions include grants and funding incentives and rewards. Significant improvements in EMR use can be realized in primary healthcare settings where interventions (professional, organizational, and financial) have been implemented targeting the use of EMR functions and data quality.
Huang et al. (2018)	Healthcare workers and expert consultation with clinicians and knowledge users (Canada, Switzerland, UK, US)	Method: Scoping review (37 articles) Outcomes of Interest: EMR use	EMRs	Common measured functions include performance reporting, privacy/security, viewing medication lists and laboratory results, prescription/laboratory orders, electronic transmission of health information/prescriptions, use of drug/care alerts, and public health reporting. Measuring use through individual EMR functions is the most prevalent metric encountered, most commonly done by surveys. Direct observation and semi-structured interviews can provide detailed evaluation of use but are time intensive. Electronic reporting may be the most promising evaluation method. (|) There is limited use of advanced features in EMRs among Canadian primary care practitioners. Understanding advanced	Given the rising use of EMRs, and the link between advanced use and potential benefits to patient care, it is important to measure EMR use effectively. It is important that measures of EMR use are applicable to the processes and structures within the Canadian primary care system. Creating a unified, multi-dimensional use assessment framework, and applying it consistently across jurisdictions would simplify the process of evaluating use. Electronic reporting presents an objective and efficient method to evaluate use; however, the capability to do so must be present in the EMR software. Examples include reporting

				EMR use is a complex task, and currently there is a lack of information for the Canadian context.	electronically through the EMR system and using EMR audit data to determine levels of use.
Kash et al. (2017)	No target population specified	Method: Systematic review (12 articles) Outcomes of Interest: Type of hospital, type of disease, type of intervention or strategy, name of program, description of program, setting, impact on readmission rate, and type of health information exchange (HIE)	HIE (Telemonitoring, telephone follow-ups, collaboration with other caregivers)	Telemonitoring support systems combined with case management (long-term ongoing care) was associated with a 44% decrease in 30-day readmissions in high-risk populations. Integrated medical records between hospitals and primary care clinics allow for real-time transmission of patient information and engage the primary care team in the care of the patient while hospitalized and during discharge. Regions where health systems tend to use the same vendor for their EHR vendor (e.g., Cerner, Epic) tend to engage in greater exchange of data. (+) There is limited evidence to support the financial benefits of the use of community-based HIE for readmission interventions. (|) Outcomes from EMRs: improve care coordination, reduce avoidable readmission rates, and optimize use and access to important patient information in the EHR. (+)	Health system administrators should ensure that they are actively integrating data towards HIE; this can include peer-to-peer connections, integrated EHR extending to non-affiliated providers and partners, or through participation in a community-based HIE. Organizations (both health systems and community HIEs) have semantic challenges, and effective cost, focus, and community engagement strategies must be in place to fully advance interoperability and exchange. Integration of HIE, however, will continue to face challenges until interoperability standards are in place and providers are willing to openly share patient information.
Ko et al. (2018)	Nursing home (NH) staff	Method: Literature review (46 articles) Outcomes of Interest: Workforce outcomes, including staff satisfaction, experiences with use of health information technology (HIT), effects on quality of care, productivity	HIT Technology adoption & care processes	Staff perceptions of the influence of EMRs on workflow were mixed, as well as staff satisfaction. In some studies, staff described processes as more streamlined, and in others, processes were more cumbersome, possibly as a result of inadequate preparation and training for HIT. (+/-) The evidence around documentation using EMRs had mixed results. In some studies, authors found documentation to improve significantly while others found the opposite. HIT has the potential to	Stakeholders in NH care should develop a toolkit for the NH workforce on EMR implementation that includes a facility and staff readiness assessment and a technical needs assessment, given the numerous reported difficulties with wireless connectivity and technical support that negatively impact staff ability to use HIT successfully. Stakeholders should develop a framework to integrate quality

				improve efficiency of tasks, but progress can be impeded by ongoing double-documentation with paper, workarounds, and lack of training for system updates. (+/-) EMRs can foster teamwork and communication across roles and levels of seniority within NHs. Administrators and staff frequently reported that HIT improved communication. (+) There is limited evidence of EMRs' impact on quality of care, staffing (i.e., need for personnel), or turnover. (|) Outcomes achieved by EMRs: improved NH quality indices; resident outcomes such as maintenance of daily living, range of motion, bed mobility; clinical support addressing adverse drug events and medication errors. (+) Facilitators: ongoing training and opportunities to practice using EMRs, access to 24-hour support lines, engagement of nurses and teams in the implementation process. (+) Barriers (staff-related): poor computer literacy, fear of technology, limited English ability, ongoing double-documentation with paper, work-arounds, and lack of training for system updates; (NH-related): provision of inadequate training, too few computers, insufficient support personnel, limited and/or slow Internet access, lack of wireless connectivity, and poor integration of systems. (-)	improvement initiatives with HIT implementation. Policy makers and health systems should consider making incentives and other funds available for NHs to increase investments in training supported by clinical staff, and technology infrastructure.
Kooij et al. (2017)	Combination: Patients with chronic disease; primary care	Method: Systematic review (11 articles) Outcomes of Interest: Patient health outcomes and	Information technology (IT)-supported shared care (Electronic decision support tools; Electronic platform	EHR use improved primary care provider visits and reduced re-hospitalizations, but this was not observed when used to	As IT is often a small part of these health-based interventions, it is hard to determine real added value in shared care. EHRs have evolved into

	providers, including general practitioners and pharmacists; Specialty care professionals (case managers, specialists) (Canada, Italy, Scotland, United States, Australia, Denmark, Spain, and Belgium)	provider/professional outcomes	with call center; EHRs; Electronic communication applications)	inform GPs about hospital discharges. (+/-) Electronic decision support for case management: statistically significant benefits, including increased weekly physical activity, decreased body mass index, low density lipoprotein (LDL), systolic blood pressure (BP). (+) High levels of physician, case manager, and patient satisfaction; Lower costs associated with intervention versus control groups. (+) Provider/professional outcomes: 61% of GPs preferred to continue shared care, 32% preferred shared care over usual care. (+) Clinical information about diabetes patients shared between GPs and hospital professionals had significant positive effects on clinical outcomes of glycated hemoglobin, BMI, LDL, cholesterol; But the use of synchronized health records showed no difference with usual care for most patient-related outcomes (metabolic control, psychosocial problems, sleep disturbances). (+/-, 0)	connected systems that ensure real-time information exchange and such intelligent systems can support professionals by sending automatic alerts and providing tailored advice. Real-time EHRs are regarded as the most advanced IT application support shared care according to authors. This review indicated that there are few studies to substantiate anticipated benefits of IT to support shared care (large heterogeneity of study populations and outcomes). Despite this, there were many positive effects on provider and professional outcomes and to a lesser extent, on intermediate and distal outcomes, such as costs and readmission. Authors cannot provide a firm conclusion on the effect of IT-support shared care, as they are developed rapidly and need more evidence of effects of interventions.
Kruse et al. (2017)	Combination of healthcare workers and patients in long-term care (LTC)	Method: Systematic review (28 articles) Outcomes of Interest: Outcomes associated with use of EHR in LTC facilities, including quality of care and physician satisfaction	EHR use in LTCs	9 papers reported positive quality outcomes. (+) Only 3 papers reported greater physician satisfaction using EHRs as it improved the working environment. (+ W) Document management was identified as a common theme in 13 papers, with facilitators of financial incentives, greater usability and less time spent on documentation. (+)	Recommend improving the design of EHRs that address issues such as time spent on documentation and enhancing the usability for physicians and nurses. Adoption rates for EHRs in the US greatly increased with incentives that helped to offset the steep adoption costs of the technology. Future research should work to develop the level at which the cost of investing

				Three papers mentioned that they could not observe much difference in the time consumed for documentation after implementing EHRs. (0, W) Quality outcome was second most observed theme-many papers stated that EHRs directly improved quality-of-care. (+) Four papers showed significant improvement in health outcomes by reducing occurrence of infections, among others. (+) Barriers: time spent on documentation, usability for physicians and nurses. (-)	in the EHR is equal or better that the cost of abstaining.
Kruse et al. (2018)	Healthcare providers associated with population health	Method: Systematic review (55 articles) Outcomes of Interest: Barriers and facilitators to EHR adoption	Electronic health record systems	Facilitators were identified more commonly than barriers in a 3:2 ratio. Facilitators/enablers for adoption (listed from most commonly to least commonly identified): productivity/ efficiency; quality; data management; surveillance; preventative care; communication; interoperability; decision support; health outcomes; satisfaction; financial assistance; ease of use; current technology. (+) Barriers for adoption (listed from most commonly to least commonly identified): missing data/data errors; no standards; productivity bias; technology complex; cost; decreased quality; limited staff support; resistance to change; human error; accessibility/utilization; disease management; critical thinking/treatment decisions; privacy concerns. (-) Primary care benefits: Increased utilization of prevention/primary care; clinical decision support; improved accessibility; improved access to primary care as	Organizations can maximize time with patients instead of spending time writing documentation, as evidenced by the many instances of increases of productivity and efficiency. EHRs can improve workflow in organizations. Other organizations identified a loss in productivity for the same reason, but this may have been due to the stage of implementation in which the organizations were in. With the ability to access a greater number of records in a more productive way, it is not surprising that surveillance accounted for third most recorded facilitator. Surveillance can utilize information from EHRs to make population and public health predictions and for better overall review of a population's health.

				information provides tailored quality improvement initiatives; patient safety for medications; decreases medical errors; physician satisfaction; self-efficiency; overall positive impact on overtime; consistent communication; prompts healthcare providers to screen for chronic health issues (preventative care); improve health outcomes (unspecified); facilitating care identification; increased faculty providers; longer notes. (+)	
Lor et al. (2019)	Patients and/or healthcare providers using information visualizations	Method: Systematic review (18 studies) Outcomes of Interest: Information visualizations or symptoms included as National Institute of Nursing Research (NINR) common data elements systems for use by patients or providers	Visualizations of symptoms – considered an extension of an EMR software or a software program in itself (graphs, virtual body maps, icons)	Information visualizations have been used to represent symptom information about pain, fatigue, and sleep with pain. (|) Only a few studies reported race, ethnicity, and education, while no studies in review evaluated the actual impact of use of symptom information visualizations on patient outcomes and symptom management.	More research needs to be done to assess impact of symptom information visualizations on patient outcomes/ symptom management. Increasing availability of tools for design and dissemination of information visualizations provides opportunity for visualizations beyond those that can be created in statistical programs. User-centered participatory approaches for visualization development and more sophisticated evaluation designs are needed to assess which visualization elements contextually work best for populations.
Magwood et al. (2018)	Mothers and children participating in primary care (UK, US, Australia, Canada New Zealand; low- and middle-income countries (not included in analysis) (LMICs): Brazil, Cambodia,	Method: Systematic review (19 articles) Outcomes of Interest: Quality-of-care; Health equity	Home-based records (HBRs) for maternal, newborn, and child health; Immunization records (includes paper or electronic-based)	Feasibility: No findings from perspectives of mothers, caregivers, and healthcare providers. (|) Acceptability: HBRs indicate that women, caregivers, and healthcare providers appreciate and value them. Women from high-income countries valued the ease, speed, and convenience of online HBRs. However, privacy in relation to online medical records was a consistent concern (with the exception of one study that successfully used records as part of a rare	Though technology may be seen as the future of healthcare, authors argue the scalability of electronic HBR interventions due to availability of infrastructure (but this is likely to be more of a barrier in LMICs, rather than HIC). Overall, in all populations online records appear to offer opportunities for knowledge and engagement. Use of online records seem to be acceptable among low-income populations in high-income countries. Nevertheless, there is concern about

	Palestine, South Africa)			disease network). Fear of government intervention and lack of privacy once records are online, with maternal health records, child health records, and immunization records. (+/-) Affordability: No findings from perspectives of mothers, caregivers, and healthcare providers. (|) Equity: No findings from perspectives of mothers, caregivers, and healthcare providers. (|)	privacy and security and the risk of harm to health equity when certain populations cannot take advantage of new technology. Authors suggest that policymakers need to take stakeholders' perceptions on the value of these HBRs into consideration when making decisions on the use of HBRs in their context (e.g., maternal health; electronic format; immunization record).
Maillet et al. (2018)	Primary care providers and clerical staff (Germany, Peru, Scotland, Spain, United Arab Emirates [UAE], UK, US)	Method: Systematic review (22 articles) Outcomes of Interest: Impact of HIT	HIT, EMRs, EHRs, laboratory information systems impact on the total testing process (TTP) phase and activities	Easier access to previous results allowed by IT did not necessarily reduce the number of tests prescribed for patients. (0) There were mixed results about the impact of IT on laboratory ordering processes (i.e., physician workload, appropriateness of testing, etc.). (+/-) Studies report positive impacts of health IT systems in terms of improved traceability of current tests, avoiding results going missing and preventing delays. They also provide faster turnaround times, often within 24 hours. (+) Gains were reported in terms of efficiency, process reliability, and provider satisfaction, easier access to results and elimination of the manual entry of results. However, when used in parallel, paper records were found to be more user-friendly and faster when it came to reviewing results with critical values. (+/-) There was mixed evidence related to clinicians' response to results. Some studies indicated that even if results were returned sooner to the requesting	Emphasis should be placed to avoid technical failures and user problems, including network problems and problems with nomenclature, routing of results, queries related to professional role, and synchronization of user tables. Organizational issues that were identified point to non-standardized monitoring processes, variable and often informal clinical practices whose monitoring relies on prescribers' memory, role ambiguity, and the need to establish a chain of responsibility in laboratory test monitoring. Partial implementation of an EMR or an EHR limits the ability to realize benefits due to an overload of work and failures because both paper and electronic processes are maintained. Systems such as clinical decision support system (CDSS; e.g., automated alters) and CPOE suggest best practices that enable users to make better-informed clinical decisions and may reduce error rates.

				clinician, this did not necessarily lead to a significantly faster response. (+/-) Facilitators: Positive effects were noted for computerized provider order entry (CPOE) systems integrated into an EMR by providing for better organization of prescriptions and easier test selection while reducing errors and saving time. Clinical decision support systems may support decision-making based on guidelines (e.g., Automated alerts and therapeutic plans programmed into an EMR by clinical specialists). (+) Barriers: There were reports of technical failures and user problems, including network problems, problems with nomenclature, the routing of results, queries related to professional roles, and the synchronization of user tables. (-) Response times: although EMRs may lead to faster turnaround times, it is dependent on requesting physician. (|)	EMR screen sharing can be used as a tool to explain lab test results to patients. This can even be applied in video consultation where both the patient and clinician are looking at the same result via a personal health record. EMRs improved traceability of current tests, helped avoid results going missing and provided easier access to results. Regarding outcomes achieved by EMRs, reduce the amount of effort spent by staff to collect information and encourage care that meets best practice guidelines.
Marien et al. (2017)	Analysis mainly towards system implementation and design, but reports generally involved clinicians (Canada, US)	Method: Systematic review (18 reports: 14 full publications, 2 proceedings, 2 patents) Outcomes of Interest: Identify tools and characteristics with regard to context, implementation and evaluation; Facilitators for successful development and implementation of eMedRec tools	Interventions (eMedRec tools) that fully support medication reconciliation (continuity of care) during hospital admission, outpatient, discharge, and/or post-discharge settings	Evidence remains insufficient about the impact of eMedRec tools on the quality and safety of healthcare. Success of developing and integrating technical solutions to support eMedRec is strongly dependent on attention to implementation processes and extensive usability testing. (|) At institutional level, endorsement by quality improvement leaders, highly integrated care, past experience of technology and a culture of fostering patient safety enhanced the adoption of eMedRec into routine use. (+) Usability testing is the most commonly used evaluation method for assessing	Regarding development, adopt tool workflow to the habits of frontline users, offer possibility of invoking the application from multiple points in workflow, define roles of frontline users, ensure support from hospital leaders, and persuade frontline users of importance. Develop tool features/design iteratively, choose design that matches overall design philosophy of EHR, and use prototypes and pilots. Regarding implementation, provide education and support, improve compliance with notifications, conduct

				user interaction with health IT. Clinical processes have to drive IT development and design.	usability testing, and establish process for addressing recurring errors.
O'Donnell et al. (2018)	Primary care physicians (PCPs) (Austria, Brazil, Canada, Germany, Hong Kong, Ireland, Israel, Italy, Norway, Portugal, Saudi Arabia, Switzerland, Spain, UK, US)	Method: Systematic review (33 articles) Outcomes of Interest: PCP knowledge, attitudes, and/or satisfaction with EMRs, measures of EMR use	Adoption of EMRs	Adopting factors include: ease of log-in; access to information; efficiency (speed of navigation); automation of clinical functions (e.g., prescription renewals); audit/feedback processes. (+) Discouraging features of the EMR include: effort/time to navigate; lack of accessibility, reliability, interoperability, and overall utility; limiting ability to exchange information between other practices/IT systems. (-) Facilitators: Adequate training; up-to-date policies; designated EMR champion. There are positive effects of early user involvement in design/development on eventual success of implementing EMRs. (+) Barriers: Ethics of personal data sharing and overcoming technical challenges of coordination. Financial factors most commonly shape PCP adoption (e.g., initial costs; demands required by ongoing use; lack of financial incentives). (-)	Future implementation programs must provide a forum for end-users to play an active role in the design process from the outset. There is a need to improve interoperability across systems to ensure that patients receive coordinated care of consistent quality. EMRs can improve clinical productivity, promote patient safety, and improve medication management. Policymakers and system architects designing such initiatives need to recognize that EMR programs are complex interventions, but that adoption is ultimately determined by the attitudes and preferences of the individual clinicians.
Patterson (2018)	Healthcare providers (nurses, inter-disciplinary teams)	Method: Narrative review (80 on-topic articles and 24 key articles) Outcomes of Interest: HIT		Users circumvented new additional steps in workflow when using HIT. Team members communicated via HIA in text fields intended for other purposes. Paper-based and manual whiteboard systems were used instead. Workarounds identified reduce interruptions and disruptions to workflow. Unstructured text was used for storage and recall (e.g., Physician noted patient went on a fishing trip so that next staff could ask how trip went next visit). (N/A)	Authors recommendations are general to HIT, providing three implications for practice: 1) Provide summary overview displays to support individual as well as shared situation awareness; 2) Design HIT to explicitly support communication across roles for specific activities even when those who receive the communication are not identified in advance; and 3) Reduce the risk to reputation due to potential electronic monitoring of

			Workarounds were used when there was no other way to communicate, when other ways were possible but were harder to access, and when EHR was in use/took more time. Electronic whiteboard was used less despite active discouragement for manual whiteboard use. Functionality was better supported by manual whiteboard and facilitated shift change handovers.	individual performance. (Legal requirements, trade-offs need to be actively considered for each implementation). There will be increased interest to steer away from paper-based systems, but this is predicted to increase frequency and complexity of workarounds.
Rathert et al. (2017)	Adult patients (not including dental or psychiatric patients) and their physicians (Australia, Canada, Denmark, Israel New Zealand, Norway, UK, US)	Method: Systematic review (41 articles) Outcomes of Interest: Communication functions of interest	Physician interactions with EHRs consumed larger percentages of visit times than paper charting; yet, no studies directly tested whether this was associated with relationship changes. (-,|) There are mixed reviews as to whether EMRs improve accuracy. (+/-) Physicians who focus more on the EMR (i.e., gazing at the EMR, having more silent time) make fewer emotional and psychosocial inquiries of patients. The combination of extended focus on the computer and time pressures during care encounters may cause a physician to neglect elements of a patient's story, along with any emotional and/or psychological cues essential for rapport. Furthermore, patients are concerned about confidentiality of their EMR data, leading to a new layer of uncertainty for patients to manage. (-) EMRs help with diagnosis, decision-making, and treatment plans for complex patients. Patient interfaces facilitate greater self-engagement and self-management. Patient portals and secure messaging may help patient keep track of past history and prepare for future encounters. (+)	Patient portals and secure messaging could serve to improve relationships; such applications tend to increase patient engagement and adherence, while not significantly increasing physician workload. Benchmarks for patient throughput should consider that it takes significantly longer to enter information into the EMR than paper charts. Organizations should make sure equipment is physically organized to enhance collaboration with patients. There is a need to develop programs that incentivize key communication functions that have shown to improve patient outcomes, as opposed to simply rewarding the use of specific features. EMRs are able to enable capture sharing, analysis of biomedical information, diagnosis, decision-making, and development of treatment plans. EMR use may empower patients and get them more engaged and involved in collaborative relationships.

Taylor (2017)	Healthcare staff including doctors	Method: Literature review (45 articles) Outcomes of Interest: Current challenges of chiropractic EHRs and suggestions for future directions	Reports indicated consistent problems that affected the quality of the documentation. Commentaries revealed the use and misuse of the documentation information generated by EHR systems. Primary challenges with EHRs were in proper documentation, financial constraints, logistical changes in workflow, intrusion into the doctor-patient relationship, and difficulty in implementing the new process. (-) Ability to integrate appropriate clinical data into EHR was dependent on quality of software. Barriers to effective use of EHR included: financial constraints, changes in workflow, intrusion of doctor-patient relationship, difficulty implementing new process. (-)	Chiropractic EHR systems need to have features that allow customization of each encounter, to allow the appropriate documentation that attends to the basic document requirements. This review provides an indication of the need for ongoing financial incentives as governmental incentives (to start using EMR) expire. Success of full implementation and utilization is dependent on training including the sociological aspect of utilizing EHR during patient contact.
Venzon et al. (2019)	No target population specified (analysis of data entries)	Method: Systematic review (42 articles) Outcomes of Interest: Social determinants of health (SDOH) in electronic systems including EHRs, strategies for widespread use of SDOH in healthcare delivery	Few SDOH data are captured in EHR source, meaning that EHRs are not fully utilized to capture and code social health data. No standards identified for most of the SDOHs in EHR sources, which was identified as a barrier for integrating SDOHs in EMRs. (-) Financial resource strain has consistently proved to be the most important data element to collect from patients. Financial resource strain is often captured but other recommended SDOH are not. There is substantial work to be done to reach the recommendations of the Institute of Medicine for capturing SDOH in EHRs. (+/-)	While there are benefits to unstructured financial data that allows narrative expression, structured data still promote reusability and transferability of patient data in electronic systems. Structure and standardization of data are key to managing SDOH in EHRs more easily and allowing information exchange across systems. There is great potential in automating large amounts of SDOH data. This automation can reduce burden of manual data input and give nurses, physicians, and healthcare staff more time to spend with patients.
Wisner et al. (2019)	Clinicians (RNs, midwives, physicians) using EHRs (United States,	Method: Integrative review (18 articles) Outcomes of Interest: Effectiveness of electronic	Cognitive work/tools of navigating EHR: Most studies found that entering, retrieving, and/or synthesizing information was difficult and either increased cognitive workload or failed to provide necessary	This review challenges the assumption that EMRs have improved communication, access to information, and aid in decision-making. EMR use has generated numerous cognitive

	Scandinavia, Australia, Austria and Canada)	health record; cognitive work/workload by clinicians	cognitive support. Summary reports generated from EMRs were insufficient as tools to support nurse information management during their shift and at handoff. The tools often did not match how nurses thought or worked, resulting in reliance on paper notes and verbal exchanges. (0, +/-) Shared understanding of the patient: Some studies indicated better care coordination. However, increased volume and electronic exchange of information did not enhance communication to facilitate mutual understanding of meaning and shared situation awareness. Emphasis on objective information and other preconfigured templates impeded ability to decipher colleague interpretations. Loss of professional knowledge: Nurses relied on disposable forms of documentation. Notes were not read by others, suggesting that nurses' professional knowledge are not integrated into team processes. Several studies reported increased variability and inconsistency in where data were documented.	challenges for clinicians that may have important safety implications. Template-driven documentation facilitates data entry, but information is less informative. Documentation completeness and increased volume of information can make it difficult to locate and process content, reducing clinical usefulness and failing to offer concise summaries. Irrelevant, truncated, or outdated information increases clinicians' cognitive work. EMR's focus on aggregation and storage of information is at odds with clinical work and yielded tools that were too generic and cluttered to be useful to nurses. EMR provide limited support for care coordination and professional communication, resulting in poor patient overview, data fragmentation, cognitive work, and difficulty deciphering colleagues' clinical reasoning. EMRs are often misaligned with clinical workflows.
Wu and LaRue (2017)	Healthcare providers experiencing implementation of HIE system (United States)	Method: Systematic review (39 articles) Outcomes of Interest: Challenges and promoters to adoption (organizational; end user)	Organizational promoters: functioning software applications; professional/social networks; subsidies/performance incentives; provision of training; technical assistances during/after adoption, support from non-clinical staff, removal of legal barriers; security of data. (+) Organizational barriers: privacy/security, sustainability/funding, proprietary issues, governance, lack of data standards around the exchange of clinical data,	Government should develop or encourage vendors to develop common data standards, plan nationwide HIE infrastructure, and provide practical ongoing funding support for the long-term success of HIE. Policymakers should focus on developing policies to help to remove common obstacles: continuous funding, payer engagement, data ownership, data standards for HIE, privacy, and liability protection.

	patient consent, and uncompensated care burden. (-) End user promoters: usefulness/usability; technical assistance, financial incentives, single automated log-in, role-specific customization, notification of data availability, early user engagement. (+) End user challenges: lack of capital, start-up costs, time constraints, system selection, multiple logins, prolonged data retrieval, frequent timeouts, redundant data, physiological incompatibilities, misalignment with workflows, vulnerable information accessibility/misuse, and mistrust in external HIE partners. (-) Outcomes achieved by EMRs: efficiency, improved quality of care, cost reduction. (+)	Vendors should work with clinicians to design customized user-friendly HIEs, integrative to current workflows, aiding during and after implementation to facilitate HIE adoption and sustainability. Healthcare organizations should follow laws and regulations regarding HIEs, allocate appropriate human resource, and encourage effective communication, shifting from an ownership view of health data to a continuity of care perspective. Clinicians should understand the value/proper usage of HIEs to provide feedback to IT staff. IT should address interoperability obstacles and HIE sustainability.

Legend: The following symbols explain the evidence effect/impact of intervention on outcomes; + (positive effect), - (negative effect), = (equal effect to traditional intervention), I (inconclusive, limited evidence), 0 (null effect, no effect observed), +/- (mixed effect), N/A (not applicable), W (effect is weak in strength).

Commonly used acronyms: Blood Pressure (BP), Computerized Provider Order Entry (CPOE), Electronic Health Record (EHR), Electronic Medical Record (EMR), General Practitioner (GP), Home-Based Record (HBR), Health Information Exchange (HIE), Health Information Technology (HIT), Information Technology (IT), Low Dentistry Lipoprotein (LDL), Low- and Middle-Income Countries (LMICs), Long-Term Care (LTC), Nursing Home (NH), National Institute of Nursing Research *NINR), National Programme for Information Technology (NPfIT), Primary Care Physician (PCP), Social Determinants of Health (SDOH), Shared Electronic Health Record (SEHR), Total Testing Process (TTP), United Kingdom (UK), United States (US)

Appendix D: Summary of Jurisdictional Review

Healthcare Intervention	Details/Intervention Features	Setting/ Population Served	Outcomes Achieved	Practices to Achieve Outcomes
		Sweden		
Journalen accessed through 1177.se (National Patient Portal)	Website where citizens can access their EMR, as well as search information about illnesses, symptoms and treatments and healthcare in a particular region.[1] People can send messages to their primary care centers or hospital units.[1]	Residents and providers in Sweden[1]	41% of citizens created an account by 2017 demonstrating high rate of use of service.[1] Patients are responding positively to the portal and feel that it is good for them.[1] Patients feel they are more informed, have improved communication with medical staff and have a better understanding of their health status.[2] Healthcare professionals are concerned with patients being worried when they read their records.[2]	Patients have once access point to all their health record information regardless of how many healthcare providers they have visited or which HER system their healthcare providers use.[3] The type of information that is accessible did not appear to have a major effect on the acceptance of this service.[3] Access to different types of information (e.g. test results) or the availability of a function (e.g., ability to make a health declaration) did not affect the rating of importance of this service.[3] Some healthcare professionals offer information right away and some implement a 2-week waiting period to allow healthcare professionals to have time to inform the patient in person before reading their healthcare record.[3]
Health Information Exchange (HIE)	Platform to facilitate communication between different health information systems and eHealth services.[1] Several HER systems exist across Sweden however the HIE make EHRs appear as national since HIE provides a single point of connectivity for client applications.[1]	Healthcare providers in Sweden[1]	19 of 21 regions are connected to platform. [3] Healthcare professionals have significantly more negative perceptions for system then patients.[2]	Government working with healthcare providers to shift perspectives to be more open (direct access and provision), in line with national aim to ensure all patients have immediate access to all information by 2020.[3]

Intermountain Healthcare (IHC)				
iCentra	An integrated electronic health record, practice management, and revenue cycle system. System links patient data with clinical and financial outcomes that are presented in real time. Accessible for patients, family members, and providers.[4]	Individuals in Utah, Wyoming, and Idaho	Promotes evidence-based practices.[4] Leads to improved quality of care and cost savings.[5] Decreased RBC transfusions by 30%, millions in cost savings, and reduced thirty-day mortality rates.[5]	Identification and tracking of medical costs, services, and outcomes specific to particular care processes.[6] Robust testing, learning, and training with clinical teams prior to implementation.[7] Teams of "super users," developed during the launch to provide support.[4]
Care Process Models	Best practice guidelines and digital workflow tools incorporated into the EMR.[8] Algorithmic and measurable actions that can be embedded into workflows, with outcomes linked to care pathways.[8]	Individuals in Utah, Wyoming, and Idaho	Increased efficiencies, improvements in disease-related outcomes, and reduced costs.[9-11]	Quicker and more effective implementation of new best practices.[8] Standardize approach and measurement of core clinical processes.[8] Continual improvement of CPMs using evidence from the literature and EMR data.[8] Involvement of patients, data analysts, staff champions, and medical writers.[8]
Australia				
My Health Record	Secure online platform that can be accessed by both patients and their authorized healthcare providers. Providers can upload, view, and download the following documents: Shared Health Summary, individual event and discharge summaries, specialist letters, referrals, and pharmacy prescription and dispense records. An e-referral system, patient private health diaries, and a mobile application for child development are also available.[12]	All individuals covered by Australia's publicly funded healthcare system, and thus assigned an Individual Healthcare Identifier (IHI). [13]	In its first year of operation (opt-in strategy), only 400,000 individuals created a My Health Record, 58% of which were facilitated through healthcare providers (rest were done online, by mail, by phone, or in person).[12] Following 2018 reform (opt-out strategy), 90% of eligible population had a My Health Record (national opt-out rate of 10%)[14] Pre-reform qualitative studies showed high acceptability for the opt-out strategy among patients and providers, relative to opt in.[15]	Opt-in strategy involved voluntary registration for a My Health Record by both patients and healthcare providers. Patients could register online, by phone, by mail, or in person. [12, 15] Opt-out strategy involved automatic creation of a My Health Record for all patients with a valid IHI; prior to this, patients were given one year to opt out. Individuals that initially chose to opt out are still able to create a My Health Record at any point, while those with a record are likewise able to request its deletion.[15]

Sources: [1]Philips, 2017; [2]Moll et al., 2018; [3]Maria et al., 2018; [4]Intermountain Healthcare, n.d.-b; [5]Ott & Olsen, 2019; [6]Conn, 2015; [7]Intermountain, 2016; [8]Intermountain Healthcare, 2017; [9]Byington et al., 2012; [10]Nkoy et al., 2015; [11]Patel et al., 2017; [12]Department of Health and Ageing, 2013; [13]Department of Human Services, 2018; [14](Australian Digital Health Agency, 2019; [15]Siggins Miller, 2016

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