

Evaluating the Impact of EMR Implementation in the Australian Health System: A Scoping Literature Review

Michelle Middleton¹

¹Affiliation not available

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Abstract

Background

An EMR is an electronic medical record, also known as an electronic health record (EHR), and is a computerized database containing patient information (demographics, admission data, clinical notes, test results, medications, etc.) and accounting information (McGraw-Hill, 2002). EMRs often include additional features to streamline care, such as decision aids for clinicians, and theoretically improve efficiency and reduce human error in healthcare (Australian Digital Health Agency, 2021; Duckett, 2018b).

The Australian public health system has only started to implement EMRs and related technologies to advance digital health over the past decade or so, amongst a complex and fragmented funding system shared between the Commonwealth and the States and Territories (Duckett, 2018b; Jedwab et al., 2019).

To ensure compliance with the 2020-25 National Health Reform Agreement (Australian Government Department of Health, 2022), so that value for money can be achieved in an area where competition for resources and funding is fierce, this scoping literature review will identify the available evidence, what opportunities there are for improvement, and where Australia has excelled.

Evidence check question

This review was guided by the question: ‘Has the success of electronic medical record (EMR) implementation been evaluated both quantitatively and qualitatively in the Australian health care system?’

Objective

To review available evidence evaluating EMR implementation across all health settings in Australia, to identify current knowledge gaps, and provide recommendations for future research on evaluation strategies.

Summary of methods

A scoping literature review of primary, peer-reviewed, academic literature was performed by a single researcher to identify and map the available evidence over the past decade (2012-2022) in Australia only. The PRISMA-ScR methodology was followed, with a critical appraisal of individual evidence sources assessed against the MMAT integrity checklist. A thematic analysis of findings was then performed on the shortlisted articles. Because there was no primary data collection involved, ethical approval was not required (Griffith University, 2022).

Key findings

25 papers met the inclusion criteria. Approximately half of the studies (n=12) were qualitative, nine were quantitative in nature, and four were mixed-methods studies. There was an even split of studies in the Victorian and New South Wales settings (32%

each) and just 8% in Queensland. The remainder did not define the location setting.

14 studies targeted nurses, three targeted midwives, allied health professionals, and aged care workers, seven targeted pharmacy staff, and eight targeted doctors/medical staff. Only seven were pre-post studies, most of which (n=5) were quantitative & based in NSW.

11 of the 25 studies disclosed which EMR system was being assessed, the majority of which were from Cerner (Cerner Millennium).

High-level findings were grouped into the following topics: patient safety, efficiency, medication management, usability, documentation, workforce satisfaction, and patient outcomes.

Evidence bases of shortlisted articles by topic (articles could be assigned more than one topic)

Further analysis allowed the above topics to be grouped into the following high-level themes for discussion:

- Quality & safety
- Service delivery
- Workforce-related

Conclusion

There is no consistent framework to evaluate EMR implementation in Australia, making return on investment, and impacts on healthcare delivery difficult to define. Overall, Australia has answered the call to arms to increase their evidence base. However, given the complexity designing and executing research in this field, the quality and quantity of available evidence may not be sufficient to drive policy reform or recommendations for future evaluation strategies, since most of the evidence is qualitative. The evidence captured in this scoping review generally supports EMR implementation, demonstrating benefits such as improved efficiency, safety and patient outcome; though is constrained by research based on various EMR systems in different settings and among different user groups. The use of validated, standardized evaluation tools such as WOMBAT, STAMP and NuHIS is advocated to ensure consistency and reliability in future evaluations.

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The World Health Organisation in their National eHealth Strategy Toolkit (World Health Organization & International Telecommunication Union, 2012) emphatically state the importance and benefits of results-based management (a framework used by the United Nations). This is crucial in the health sector to optimize scarce resources, improve accountability, and enhance sustainability and effectiveness of operations or program activities. Monitoring and evaluation of eHealth strategies (including EMR implementation) enables quantification of outcomes being delivered and can help communicate this to stakeholders (for example, for investment purposes), and enable corrective action to address outcomes not achieved.

In 2013, The Victorian Auditor-General's Report on Clinical ICT systems in the Victorian Public Health Sector identified that the department and health services are unable to report on benefits realisation or outcomes from clinical ICT systems (EMRs). Therefore, the Department of Health cannot have effective financial oversight or to be able to assess value for money between varying EMR / clinical ICT systems (Victorian Auditor-General's Office (VAGO), 2013).

Although this is the landscape in Victoria, it should be noted that the digital health strategies of other states all emphasise the importance of ensuring value for money is obtained from technologies, processes, and systems through the use of a benefits realisation framework (ACT Government (Health), 2019; Government of Western Australia Department of Health, 2019; Northern Territory Government, 2020; NSW Government, 2021; Queensland Government, 2015; Rockliff, 2021).

Australia needs to bolster its own national evidence base surrounding the outcomes of EMR implementation because Australia faces unique geographical, funding, and political challenges not faced by other origins of literature such as the US and Europe (Jedwab et al., 2019).

Almost ten years on from when Australia started its digital health journey of EMR rollouts (Duckett, 2018b; Jedwab et al., 2019), how much of practice has been translated into research, accessible for future learning and optimisation of decision-making?

To ensure compliance with the 2020-25 National Health Reform Agreement (Australian Government Department of Health, 2022), so value for money can be achieved in an area where competition for resources and funding is fierce, this scoping literature review will identify the current evidence base, where there are opportunities for improvement, and where Australia has excelled.

Definitions and key terms

This report will reference the technology in question as EMR(s), which includes research using the interchangeably used terms in **Table 1 below** .

Table 1 Definitions of interchangeable EMR key terms used in search strategy

Term	Definition & Rationale for Use in Search
Electronic Health Record (EHR)	Defined as “a longitudinal electronic record of patient health information”
Electronic Patient Record (EPR)	“An electronic record of health-related information on an individual”
Digital Health (Record) (DHR)	“[A]n umbrella term referring to a range of technologies that can be used to improve health care”
Electronic Medication Management System(s) (EMMS)	“... a broad term covering all computer systems involved. It is a...”

Methods

A scoping literature review is a systematic method to map the available evidence of a topic and can be used to identify and analyse knowledge gaps. Outcomes of a scoping review can be used to direct further research, or even support recommendations, depending on the topic (Munn et al., 2018; Peters et al., 2021; PRISMA, 2021; Rethlefsen et al., 2021). Since the research question is to determine the evidence base surrounding EMR implementation in Australia, that a scoping literature review would be the most appropriate methodology.

The review included the following five key phases:

1. Identifying the research question
2. Identifying and selection of relevant studies
3. Evaluation of data
4. Thematic analysis
5. Summarising and reporting results

Prior to data collection, an exploratory search was performed to ascertain scope and eligibility criteria suitable for the time and researcher constraints.

Research question & objectives

This review was guided by the question: ‘Has the success of electronic medical record (EMR) implementation been evaluated both quantitatively and qualitatively in the Australian health care system?’ broken down into the objectives in **Table 2** .

Table 2: Research question breakdown and objective

Question breakdown	Objective
Has the success of EMR implementation been evaluated in Australia?	Perform a scoping literature review to find evidence of evaluation of EMRs in the Australian context.
If so, has this been quantitatively or qualitatively?	Perform a comparative analysis of the literature review to determine what measures of evaluation/success have been published and whether they are qualitative or quantitative.

The search strategy is outlined below. The studies were categorised based on similarities in their main objectives and findings to enable thematic analysis.

Scope

The scope of this review was confined to:

- Primary academic literature reporting on Australian outcomes of EMR systems.
- Literature published over the last decade only due to the recency of technology (Jedwab et al., 2019).
- Outcomes reported in all healthcare settings: hospitals, aged care, allied health, and primary and community health.
- EMR technology only (not supplemental technologies linked to EMRs such as secure messaging).

Data sources and search strategy

The initial search was undertaken in April 2022 on studies published between 2012 and 2022, in the following databases accessed via Griffith Library and Google Scholar search engines: Medline, Web of Science and Scopus. **Appendix 1** provides a list of search query combination terms used to search the databases. The key term EMR is also used interchangeably with the terms in **Table 3 below** (Zurynski et al., 2021), which were also used to capture the full range of research. Refer to **Table 1** for definitions of these terms.

Table 3: Search terms used in scoping literature review

Key term	Search terms / Boolean Operators
EMR	EMR OR “electronic medical record*” OR EHR OR “electronic health record” OR “digital health record” or
Evaluation	Evaluat* OR success OR adopt* OR outcome* OR “outcome measure*” OR “performance measure” OR “imp
Australia	Australia*

Ethics

Patients or the public were not involved in the design or reporting of this review, and there was no funding source or conflicts of interest. According to Griffith University policy, no ethical approval was required (Griffith University, 2022). This study was not formally registered.

Evidence grading

Since the primary objective of this study was to identify the type of Australian literature available, of which quality is one component, the Mixed Methods Appraisal Tool (MMAT) was deemed the most efficient and suitable integrity checklist to evaluate the evidence due to its simplicity (Hong, Quan Nha, Fabregues, Sergi, et al., 2018; Hong, Quan Nha, Pluye, Pierre, et al., 2018).

Eligibility criteria

Eligibility criteria are summarised in **Table 4** below.

Table 4: Eligibility criteria

Inclusion Criteria	Justification
Primary academic research.	Most relevant research
Qualitative research, quantitative research & mixed methods research.	Critical to answering
Peer reviewed research only.	Quality assurance.
All healthcare settings (primary & community care, aged care, allied health and hospital / tertiary).	EMRs or their equivalent
Research conducted in Australia only between 2012 and 2022.	Australia has a unique

Approach

The Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-S) was used to guide article selection and data extraction, represented in **Figure 2** (PRISMA, 2021).

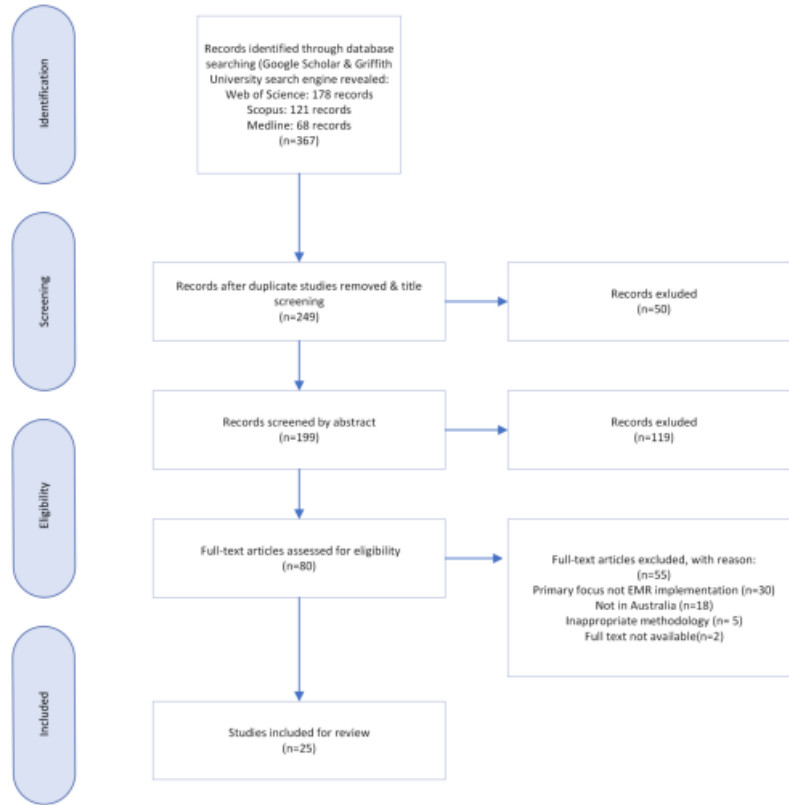


Figure 2: PRISMA-ScR approach used in this scoping review

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Data extraction

Articles that met the eligibility criteria were extracted using EndNote, where duplicates were removed. Studies were then organized by topic in Microsoft Excel (supplemental data files 1-3 available upon request).

Thematic analysis

Pivot tables were used to analyse results and perform a thematic analysis. Topics that were initially identified in the data extraction phase were then grouped into themes, with some reorganisation of topics (for example, there were three articles in a miscellaneous column, which were reassessed and regrouped accordingly).

Results and Thematic analysis

25 papers met the eligibility criteria and were broadly grouped into the topics shown in **Figure 3 below**.



Figure 3: Evidence base of shortlisted articles by topic (articles could be assigned more than one topic)

Almost 50% of studies were qualitative in nature (see **Figure 4** below).

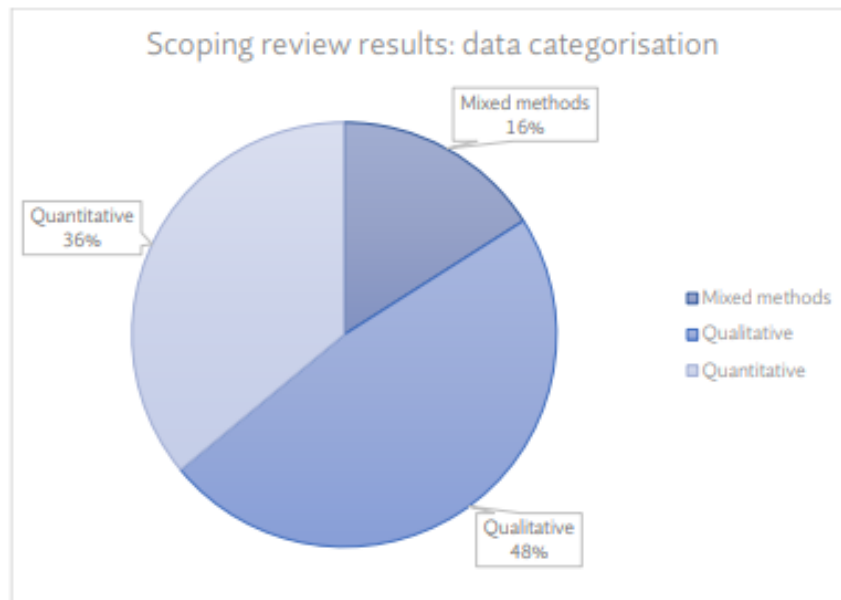


Figure 4: Scoping review results: data categorisation

Seven of the 25 shortlisted articles were pre-post studies. These were most likely to be quantitative in nature, as demonstrated in **Figures 5 & 6** below.

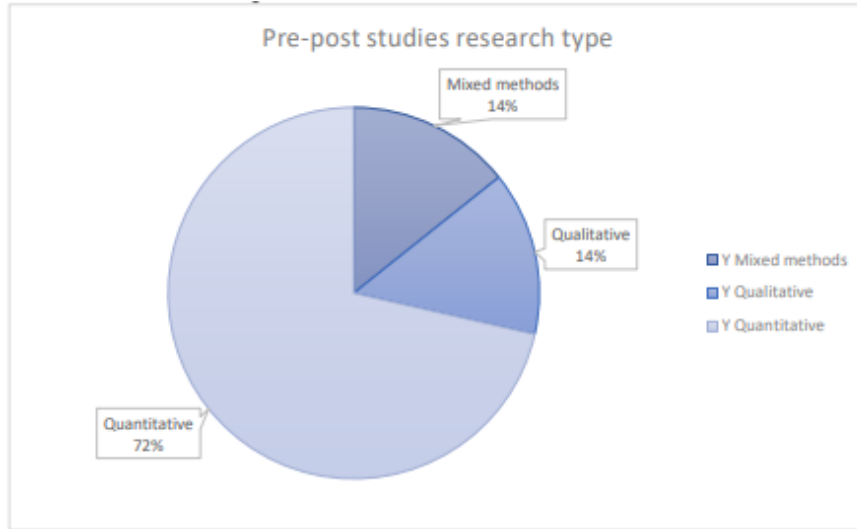


Figure 5: Scoping review results: data breakdown of pre-post studies

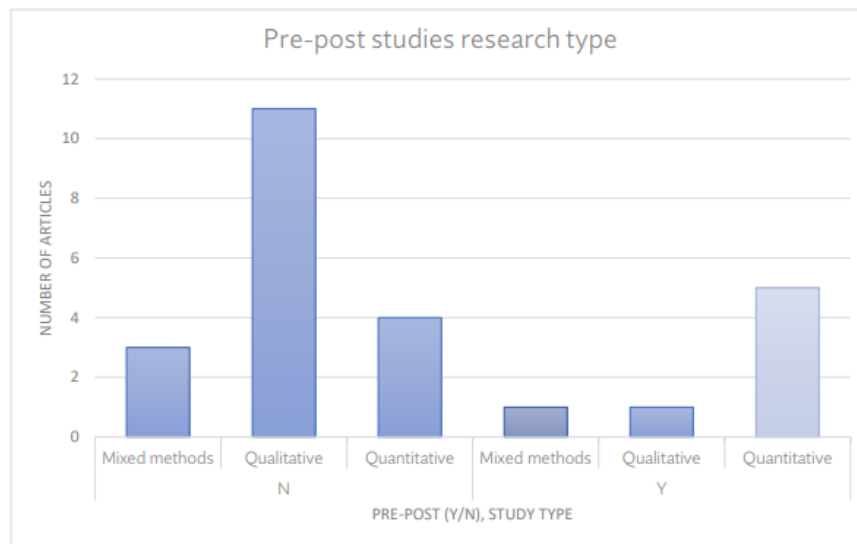


Figure 6: Scoping review results: pre-post study data types

12 of the 25 articles disclosed the EMR system analysed in the studies. The most common system reported on in the literature, based on the parameters of this scoping review was Cerner Millennium (a quarter studies who disclosed their EMR). Cerner as a brand overall was represented in 50% of the shortlisted studies.

Research was primarily conducted in Victoria and New South Wales, as demonstrated by **Figures 7 & 8** below.

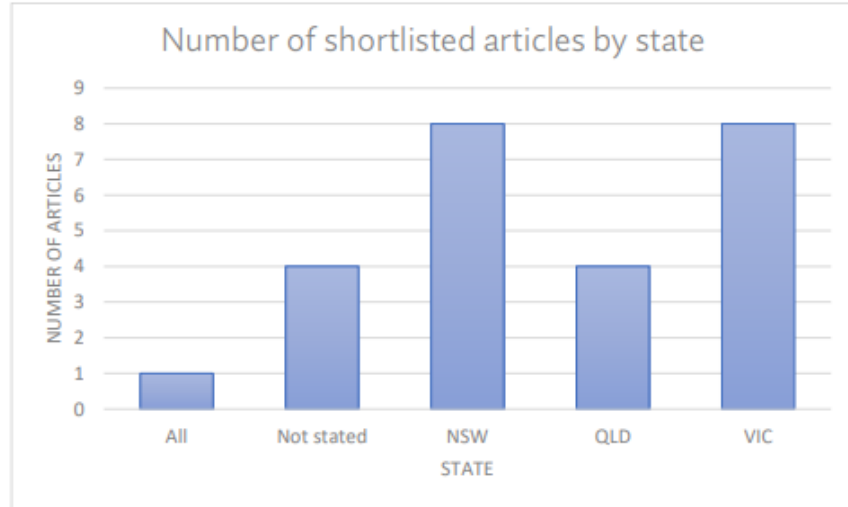


Figure 7: Scoping review results: research by state

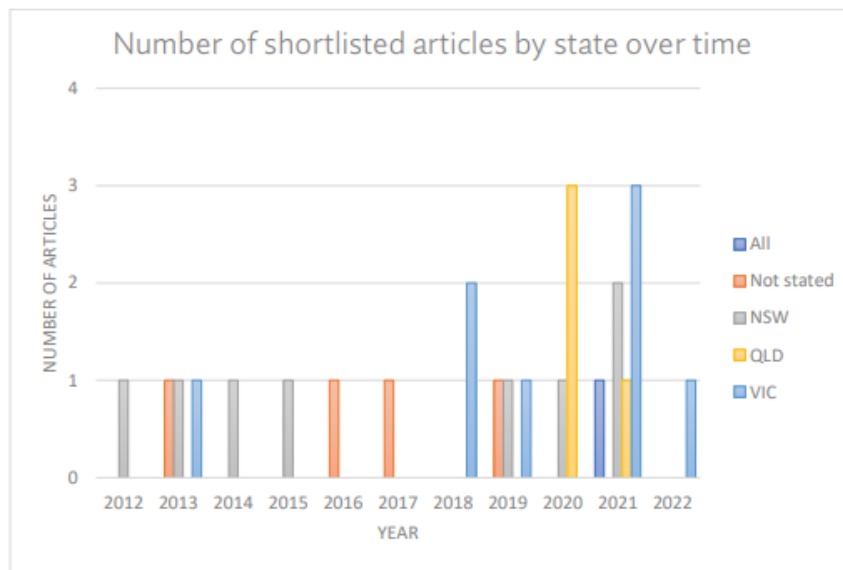


Figure 8: Scoping review results: research by state over time

Since 2017, there has been an increase in published research evaluating EMR implementation, primarily in Queensland and Victoria. The sentiment of findings relative to state is demonstrated in **Figure 9**. The articles were classified according to the criteria outlined in **Table 5**.

Table 5: Sentiment criteria

Sentiment	Definition
Positive	If findings were described with the inclusion of words such as ‘improvement,’ ‘satisfaction,’ or implied pro

Sentiment	Definition
Negative	If findings were described with the inclusion of words such as ‘deterioration,’ ‘dissatisfaction,’ or implied
Mixed / neutral	If findings did not fall into the positive or negative sentiments as above. For example, reporting on a met

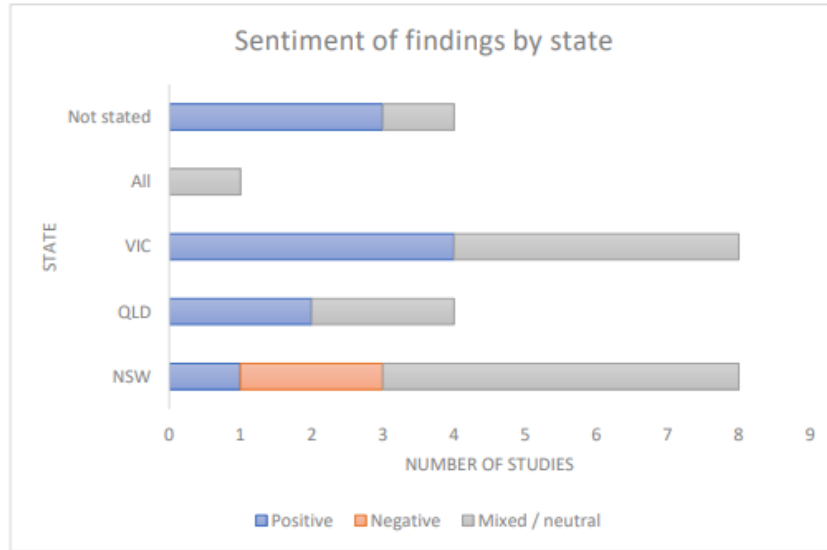


Figure 9: Scoping review findings: sentiment of findings

Most articles included in this scoping review were of high to very-high quality, based on the MMAT grading system (see **Figure 10**), and this has increased over recent years (demonstrated in **Figure 11**), as has the total amount of published research (**Figure 12**). An article published in 2022 (South et al., 2022) was excluded in the formation of **Figure 12** because this scoping review was conducted in the first quarter of 2022, meaning there would be fewer articles published this year to date, which would nullify the trend.

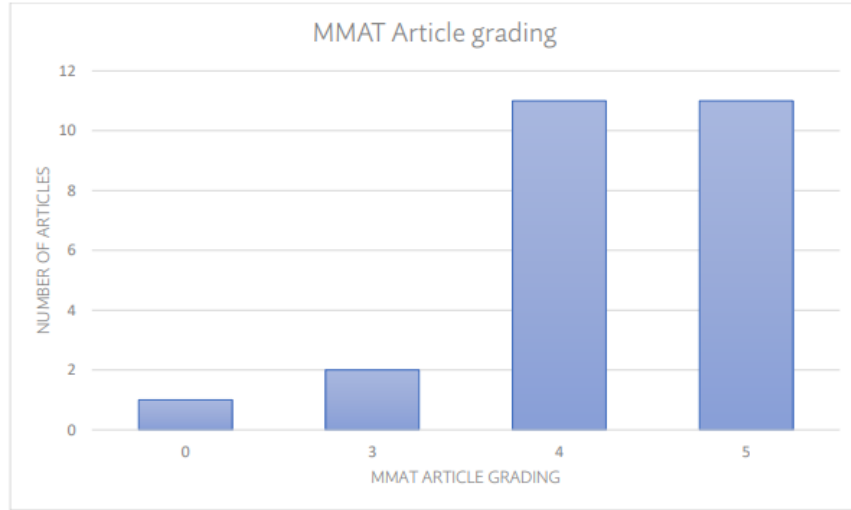


Figure 10: Articles grouped by MMAT grading

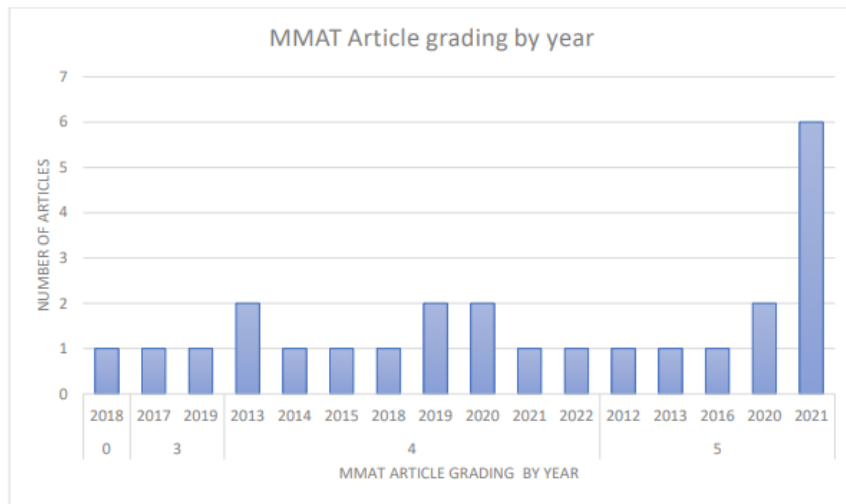


Figure 11: Articles grouped by MMAT grading over time

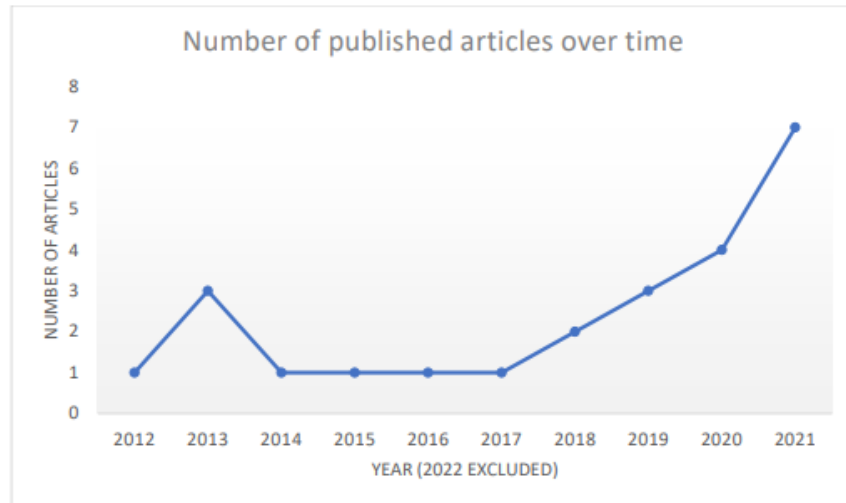


Figure 12: Quantity of Australian research published over time

Health workforce groups

Health workforce groups were generally represented evenly, with the exception of allied health staff and midwives being underrepresented in the literature. This impacts usability and worker satisfaction, as this often depends on the features being used in the EMR (Lloyd et al., 2021).

context

Most studies (n=18) were conducted in tertiary hospitals. Two studies included primary care, four were based in aged care, and one was in a government funded regional drug and alcohol service.

Approaches to evaluation: existing standards

10 of the 25 studies did not use a standardised tool, industry key performance indicators (KPIs) or acknowledged audit criteria to evaluate their area of interest.

One study stated they used ‘documentation standards’ but did not further define what they were (Wang et al., 2012). Existing auditing guidelines included:

- Therapeutic drug monitoring guidelines (Firman et al., 2021)
- The ‘Five moments of Antimicrobial Prescribing’ (Devchand et al., 2019)
- National Inpatient Medication Chart (NIMC) audit criteria (McLain et al., 2017)
- Aged Care Accreditation Standards (Jiang et al., 2016)
- Current national screening tools for substance abuse, falls and pressure injuries (Curtis et al., 2021)

Some studies also referenced the use of work sampling (E. Munyisia et al., 2014; E. N. Munyisia et al., 2012).

Approaches to evaluation: time and motion studies and before-and-after studies

Time and motion studies benefitted from use of industry validated tools, such as Work Observation Method By Activity Training (WOMBAT) (Bingham et al., 2021; Westbrook et al., 2019) which was most popular, and Suggested Time and Motion Procedures (STAMP) structured observation tool (Walker et al., 2020).

An interrupted time series (ITS) analysis was used in the most recent study by South et al. (2022): a before and after study of 355,709 hospital discharges, over an eight-year period, at a paediatric teaching

hospital.

In 2013 standard Department of Health Emergency Department (ED) KPIs were used to determine the impact of an EMR on ED service delivery (Mohan et al., 2013).

Approaches to evaluation: user experience

For user experience, Lloyd et al. (2021) used the validated National Usability-Focused HIS Scale (NuHISS) tool successfully, and promoted its future use. Dabliz et al., (2021) used the Unified Theory of Acceptance and Use of Technology (UTUAT) model.

Links between evidence themes

As referenced in **Figure 3**, articles often reported on more than one topic. For example, 10 of the 25 shortlisted studies reported on workforce satisfaction, and the same proportion reported on usability. Other topics reported together were typically medication management & efficiency, and medication safety with medication management. These will be elaborated on in the discussions section.

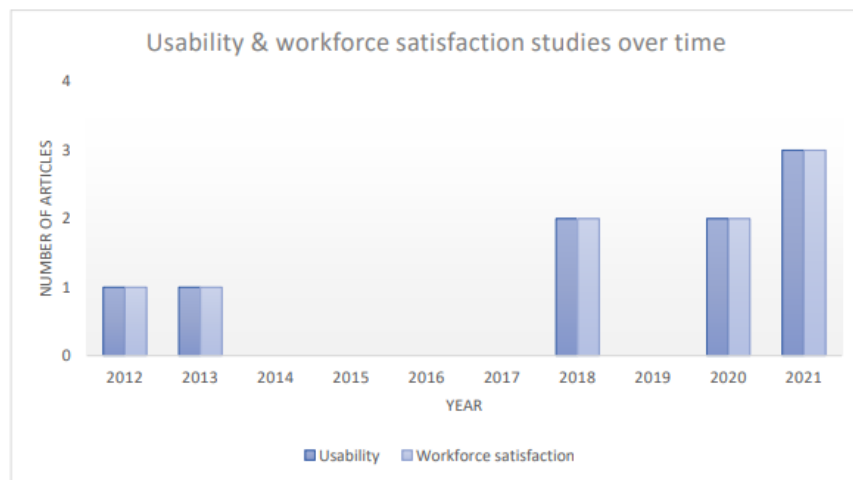


Figure 13: Common topic combinations: usability & workforce satisfaction

Figure 13 above shows there has been an increase in usability and workforce satisfaction studies over time. Despite this, there have been many recommendations from authors that more research is needed in this area (Baysari et al., 2019; Dabliz et al., 2021; Lloyd et al., 2021; E. N. Munyisia et al., 2012). Only four of the 10 studies reporting on usability stated the system used, three of which were Cerner. 50% of studies reporting on workforce satisfaction were related to Cerner.

Literature themes

Topics were grouped into the themes in **Figure 14** below, based on criteria in **Table 6**.

Table 6: Thematic analysis criteria

Theme	Topic	Article attributes
Quality & safety	Patient outcomes	Morbidity & mortality rates, treatment times.

Theme	Topic	Article attributes
Service delivery	Patient satisfaction	If patients felt EMRs impacted on their care.
	Medication safety	Error rates and types regarding EMR-based medication practices.
	Regulatory requirements	EMRs and their role in compliance with accreditation standards.
	Documentation	Quality, completion rates, comprehensiveness.
	Efficiency	Changes in length of time required to complete tasks, including documentat
Workforce factors	Medication management	Changes in workflow of medication practices, including medication review, a
	Workforce satisfaction	Acceptance and opinion of EMRs on workforce morale and workflow.
	Usability	How the design of EMRs influences the above topics, including documentati

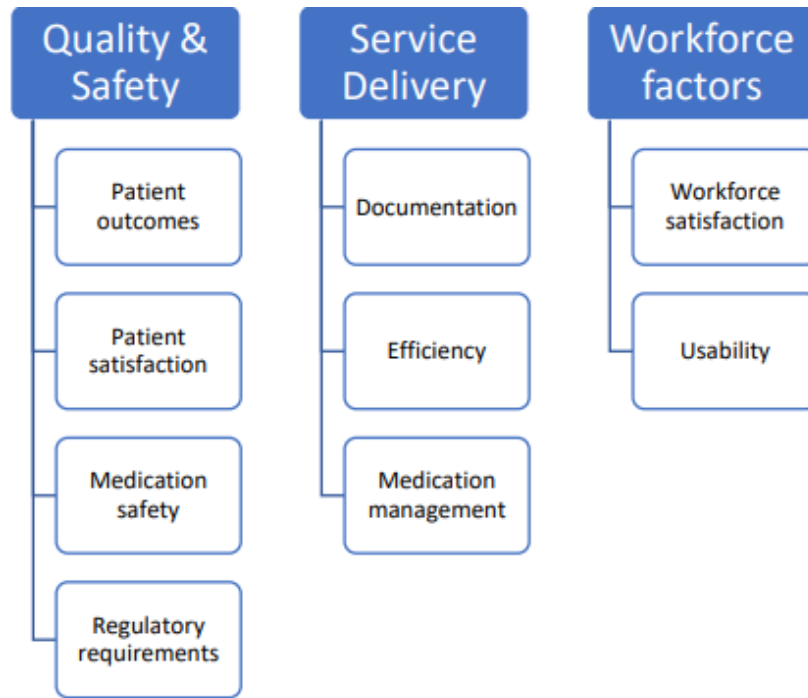


Figure 14: Thematic analysis grouping

A summary of the shortlisted articles is in **Table 7** .

Table 7: Shortlisted articles and characteristics summary

Paper citation	State	MMAT Score	Method	Context	Discipline	Brand	Topics	Theme	Evaluation measures	Evaluation time
South et al., 2022	VIC	4	Quantitative	Large paediatric teaching hospital (tertiary & quaternary services)	Multiple / all	Epic	Patient outcomes	Quality & safety	355,709 hospital discharges ITS analysis	2 years pre and post EMR implementation

Paper citation	State	MMAT Score	Method	Context	Discipline	Brand	Topics	Theme	Evaluation measures	Evaluation time
Wynter et al., 2021	VIC	5	Qualitative	Tertiary metropolitan public hospital	Nurses Midwives	-	Workforce satisfaction Usability	Workforce factors	Focus groups (retrospective)	12 months post-EMR implementation

Paper citation	State	MMAT Score	Method	Context	Discipline	Brand	Topics	Theme	Evaluation measures	Evaluation time
Witkowski et al., 2021	VIC	5	Qualitative	Tertiary metropolitan public hospital, or-thopaedic outpatient clinic	Medical professionals (intern, Resident, Non-accredited registrar, accredited registrar, consultant)	-	Documentation	Service delivery	Retrospective medical record review	Not defined

Paper citation	State	MMAT Score	Method	Context	Discipline	Brand	Topics	Theme	Evaluation measures	Evaluation time
Lloyd et al., 2021	All	5	Qualitative	Multiple: Hospitals Primary care	Nurses Medical professionals / doctors	-	Workforce satisfaction Usability	Workforce factors	Retrospective observational online cross-sectional survey. Use of validated NuHISS tool.	Not defined

Paper citation	State	MMAT Score	Method	Context	Discipline	Brand	Topics	Theme	Evaluation measures	Evaluation time
Firman et al., 2021	QLD	5	Qualitative	Tertiary hospital	Multiple	-	Documentation Medication management Medication safety	Service delivery Quality & Safety	Records assessed for appropriateness of timing of collection, compliance to recommended Therapeutic Drug Monitoring (TDM) guidelines, and pharmacist documentation.	2-year retrospective audit. 2016 (paper) vs 2018 (ieMR).

Paper citation	State	MMAT Score	Method	Context	Discipline	Brand	Topics	Theme	Evaluation measures	Evaluation time
Dabliz et al., 2021	NSW	5	Qualitative	Tertiary 750-bed teaching hospital, specialised 12-bed outpatient oncology unit	Nurses Medical professionals / Pharmacists	Cerner	Workforce satisfaction Usability	Workforce factors	Semi-structured interviews assessing usability, using validated unified theory of acceptance and use of technology (UTUAT)	6 months post EMR implementation

Paper citation	State	MMAT Score	Method	Context	Discipline	Brand	Topics	Theme	Evaluation measures	Evaluation time
Curtis et al., 2021	NSW	4	Quantitative	NSW Hospitals	Nurses	Cerner	Documentation	Service delivery	Observational pre-post: completion of industry screening tools for substance abuse, falls, and pressure injuries	1 year pre and post-EMR implementation

Paper citation	State	MMAT Score	Method	Context	Discipline	Brand	Topics	Theme	Evaluation measures	Evaluation time
Bingham et al., 2021	VIC	5	Quantitative	Quaternary hospital — medical / surgical wards	Nurses	-	Medication management Efficiency	Service delivery	Longitudinal quantitative direct observational pre and post time and motion study - using validated Work Observation Method by Activity Timing (WOMBAT)	Immediate prior to, and 6 months post-EMR implementation

Paper citation	State	MMAT Score	Method	Context	Discipline	Brand	Topics	Theme	Evaluation measures	Evaluation time
Walker et al., 2020	QLD	5	Quantitative	Tertiary hospital	Nurses	Cerner	Documentation management Efficiency	Service delivery	Structured continuous observation time and motion (STAMP) observation	Pre-post (2.5 years): 18 months post-EMR implementation

Paper citation	State	MMAT Score	Method	Context	Discipline	Brand	Topics	Theme	Evaluation measures	Evaluation time
Schwarz et al., 2020	QLD	4	Qualitative	Hospital	Allied health professionals	Cerner	Workforce satisfaction Usability Efficiency	Workforce factors Service delivery	Cross-sectional electronic survey	Varied: largest site survey disseminated 7 months post-implementation

Paper citation	State	MMAT Score	Method	Context	Discipline	Brand	Topics	Theme	Evaluation measures	Evaluation time
Qian et al., 2020	QLD	4	Quantitative	Government funded regional drug and alcohol service		-	Documentation	Service delivery	Longitudinal retrospective descriptive data analysis of patient records	10-month longitudinal post-EMR implementation

Paper citation	State	MMAT Score	Method	Context	Discipline	Brand	Topics	Theme	Evaluation measures	Evaluation time
Eden et al., 2020	QLD	5	Qualitative	Large public tertiary university hospital (one of Australia's first digital tertiary-care university hospitals)	All, including administrative staff, executive staff, & patients	-	Workforce satisfaction Usability Medication management	Workforce factors Service delivery	Single-site case study: semi-structured interviews + focus groups, observations and documentation	Immediate & 6 months post-EMR implementation

Paper citation	State	MMAT Score	Method	Context	Discipline	Brand	Topics	Theme	Evaluation measures	Evaluation time
Westbrook et al., 2019	Not Stated	3	Quantitative	Australian & English teaching hospitals (wards of)	Pharmacists		Medication management Efficiency	Service delivery	Parallel, cross-country, direct observational time and motion studies, using validated WOM-BAT tool.	6-month + post-EMR implementation

Paper citation	State	MMAT Score	Method	Context	Discipline	Brand	Topics	Theme	Evaluation measures	Evaluation time
Devchand et al., 2019	VIC	4	Quantitative	Tertiary care referral hospital, ICU	Infectious disease clinician, ICU consultants, Infectious disease fellow, Pharmacists	Cerner	Medication safety Medication management	Quality & Safety Service delivery	Cross-sectional prospective review: The "5 moments of Antimicrobial Prescribing" to antimicrobial stewardship (AMS) compliance.	12 months pre- and post-implementation

Paper citation	State	MMAT Score	Method	Context	Discipline	Brand	Topics	Theme	Evaluation measures	Evaluation time
Baysari et al., 2019	NSW	4	Qualitative	Paediatric hospital	Pharmacist	Cerner	Workforce satisfaction Medication management	Workforce factors Service delivery	Semi structured interviews	4 months pre- and 1-year post-EMR implementation

Paper citation	State	MMAT Score	Method	Context	Discipline	Brand	Topics	Theme	Evaluation measures	Evaluation time
Van de Vreede, Clifford & McGrath, 2018	VIC	4	Qualitative	8 hospitals	All, including midwives	Multiple	Workforce satisfaction Usability Medication management Patient safety	Workforce factors	Survey	Various – during & post-EMR implement

Paper citation	State	MMAT Score	Method	Context	Discipline	Brand	Topics	Theme	Evaluation measures	Evaluation time
Poon et al., 2018	VIC	1	Mixed methods	Hospital, outpatient dermatology clinic	Medical staff	Custom	Workforce satisfaction Usability Efficiency Patient safety	Workforce Factors Service delivery Quality & Safety	Qualitative data obtained by survey, combined with administrative data (number of patients seen per session).	6-12 months post-EMR implementation

Paper citation	State	MMAT Score	Method	Context	Discipline	Brand	Topics	Theme	Evaluation measures	Evaluation time
McLain et al., 2017	Not stated	3	Qualitative	2 tertiary teaching hospitals	-	CSC Med-Chart (Turner)	Documentation Medication management Medication safety	Service delivery Quality & Safety	Retrospective study assessing paper and EMRs against National Inpatient Medication Chart (NIMC) criteria	Post-EMR implementation, time period not defined.

Paper citation	State	MMAT Score	Method	Context	Discipline	Brand	Topics	Theme	Evaluation measures	Evaluation time
Jiang et al., 2016	Not stated	5	Qualitative	Aged care	Managerial- & administration staff		Regulatory requirements	Quality & Safety	Retrospective qualitative content data analysis using Aged Care Accreditation Standards	Not defined

Paper citation	State	MMAT Score	Method	Context	Discipline	Brand	Topics	Theme	Evaluation measures	Evaluation time
Qian, Yu & Hailey, 2015	NSW	4	Mixed methods	Aged care (high level of care)	Medications staff: Registered nurses Enrolled Nurses Personal carers with qualifications in medication management		Usability Medication management Medication safety Efficiency	Workforce factors & Safety Service delivery	Time-motion observation case-study	18 months+ post-EMR implementation

Paper citation	State	MMAT Score	Method	Context	Discipline	Brand	Topics	Theme	Evaluation measures	Evaluation time
Munyisia, Yu & Hailey, 2014	NSW	4	Quantitative	Aged care (high level of care)	Registered nurses, Enrolled nurses, Personal carers	-	Efficiency	Service delivery	Observation work sampling (validated): prospective longitudinal cohort case study	Pre-post 25 month longitudinal study

Paper citation	State	MMAT Score	Method	Context	Discipline	Brand	Topics	Theme	Evaluation measures	Evaluation time
Mohan, Bishop & Mal-lows, 2013	NSW	4	Quantitative	Tertiary teaching hospital	Emergency department (ED) staff	Cerner	Patient out-comes Efficiency	Quality & Safety Service delivery	Retrospective quantitative observational cross-sectional analytic study (or case control as control was prior to EMR) using government KPIs for public EDs	3 months post-EMR implement

Paper citation	State	MMAT Score	Method	Context	Discipline	Brand	Topics	Theme	Evaluation measures	Evaluation time
Fairley et al., 2013	VIC	4	Mixed methods	Primary care (sexual health)	Medical professionals / doctors Nurses	-	Patient outcomes Workforce satisfaction Documentation Usability Medication management Efficiency	Quality & Safety Service Delivery Workforce factors	Pre-post observational study	Not defined

Paper citation	State	MMAT Score	Method	Context	Discipline	Brand	Topics	Theme	Evaluation measures	Evaluation time
Wang, Yu & Hailey 2013	Not stated	5	Qualitative	Aged care	Registered - Nurses Enrolled Nurses		Documentation	Service delivery	Retrospective audit to assess completeness, comprehensive-ness & compliance with record standards	Not defined

Paper citation	State	MMAT Score	Method	Context	Discipline	Brand	Topics	Theme	Evaluation measures	Evaluation time
Munyisia, Yu & Hailey, 2012	NSW	5	Mixed methods	Aged care	Aged care worker Primary care giver	-	Workforce satisfaction Documentation Usability Efficiency	Workforce factors Service delivery	Longitudinal cohort case study using work-sampling technique.	4-12 months post-EMR implementation

Paper citation	State	MMAT Score	Method	Context	Discipline	Brand	Topics	Theme	Evaluation measures	Evaluation time
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Discussion

The above themes are discussed in further detail below as part of the thematic analysis. Some articles were re-grouped based on the overarching themes.

Service delivery

Documentation

The major advantage of computerized documentation is legibility, which was highlighted in multiple studies ((Qian et al., 2015, 2020; Wang et al., 2012).

Data entry in EMRs primarily differs from entering data in paper records in that the former allows field selection options such as drop-down menus. This introduces a new type of error which can harm integrity of documentation. Qian and colleagues (2020) discovered among all types of errors, the service option error accounted for more than half.

Compared with their paper counterparts, increased rate of completion of documentation, such as discharge summaries, management plans and screening proformas in EMRs was demonstrated in studies by Curtis and Witkowski (Curtis et al., 2021; Witkowski et al., 2021). Completion of key demographic and patient data (patient weight, for example) impacts subsequent workflows, including medication delivery, which was seen to be a benefit in Firman’s study (Firman et al., 2021).

Whereas overall completion tended to fare better with EMR vs paper systems (Wang et al., 2012), caveats remain that other factors influence completion rates. These include demands on the health workforce, training, and motivation (Curtis et al., 2021, 2021; Wang et al., 2012).

Not all studies reported positive findings in this area. Fairley et al. found no difference in quality of records between paper vs electronic (Fairley et al., 2013).

Most research in this area highlighted that documentation practices and standards can vary over time, which hinders the ability to draw conclusions about improvements longitudinally. Most of the studies use a nationally recognized paper form template to audit electronic records, which may not be tailored for electronic format (McLain et al., 2017). Studies reporting on documentation were often very domain-specific: for example, research in the residential aged care setting conducted by Wang et al., (2013) reported on factors that would not be applicable to a surgical ward in a hospital, such as ‘membership’. A resident’s cognitive capacity may also contribute to incomplete data entry (E. N. Munyisia et al., 2012; Wang et al., 2012).

Optimization and continuous education regarding documentation requirements is key to improvements in this area, and it was also recommended that further research be conducted to solidify the link between documentation and outcomes of care (Curtis et al., 2021; E. N. Munyisia et al., 2012; Wang et al., 2012).

Efficiency

Most studies reported increased efficiency after EMR implementation (Bingham et al., 2021; Curtis et al., 2021; Fairley et al., 2013; E. Munyisia et al., 2014; Witkowski et al., 2021). Several studies provided statistically significant evidence of more patients being treated in the same amount of time post-implementation compared to pre- implementation: Witkowski et al., (2021) demonstrated a 19.5% increase in patient reviews; Fairley (2013) demonstrated 5% more consultations per hour, and Curtis (2021) showed nursing staff were caring for more patients of a similar acuity in the same amount of time.

Negative impacts on efficiency were related to increased time taken for medication reviews by pharmacists (Westbrook et al., 2019) and use of mixed paper and electronic documentation systems (E. N. Munyisia et al., 2012; Walker et al., 2020).

Overall, recommendations centralized around guidance for standardization and proformas, combined with need for education and sustained continuous improvement practices (Curtis et al., 2021; E. N. Munyisia et al., 2012; Schwarz et al., 2020; Witkowski et al., 2021).

User-experience design improvements were recommended to enhance documentation features for efficiency gains by Bingham et al., (2021), Munyisia et al., (2014), Qian et al., (2015, 2020), and Walker et al., (2020), as poorly designed user interfaces can result in longer documentation times (E. Munyisia et al., 2014).

Limitations within this topic were mostly due to the observational nature of the studies, which often limits sample size and generalizability, even when standardized techniques such as STAMP and WOMBAT are used (Bingham et al., 2021; E. Munyisia et al., 2014; Qian et al., 2015; Walker et al., 2020; Westbrook et al., 2019). The presence of an observer in time and motion studies could have led to the Hawthorne effect, though this was noted in the limitations sections of these papers, and steps taken to minimize the effects (Mohan et al., 2013; E. Munyisia et al., 2014; Walker et al., 2020).

Medication management

The majority of papers reporting the impact of EMRs on medication management offered mixed findings and were often reported impartially (Baysari et al., 2019; Bingham et al., 2021; Firman et al., 2021; McLain et al., 2017). Several studies demonstrated a higher rate of pharmacist review of medication orders in EMR systems than paper systems (Baysari et al., 2019; Firman et al., 2021; McLain et al., 2017; Westbrook et al., 2019). However, few reported on whether this was a positive change or a negative one. Baysari et al., (2019) reported this had negative impacts on pharmacy staff wellbeing.

Medication management seems to be uniquely impacted by transition to an EMR, in that most studies report cannibalization of some tasks which result in either no change in completion to perform tasks, or in several instances, an increase in time required to perform medication management activities (Baysari et al., 2019; Bingham et al., 2021; Westbrook et al., 2019). This led to the recommendation that regular reviews of workflow planning post-EMR rollout are crucial for a safer and more streamlined transition from paper to digital systems (Baysari et al., 2019).

EMRs can, however, support additional initiatives to improve medication management: one study demonstrated improved antimicrobial stewardship compliance using a modified add-on to an existing EMR (Devchand et al., 2019).

Quality and safety

Patient outcomes.

Few shortlisted studies reported on patient outcomes, and findings were mixed. The most recent study in this review reported a clinically significant, sustained 22% decrease in in-hospital mortality post-EMR implementation and supports ongoing investment in these systems (South et al., 2022).

However, an older study reported a statistically significant deterioration in all ED KPIs (including ambulance offload times >30 mins and total treatment time) (Mohan et al., 2013).

Mixed impacts on patient care were reported by Wynter and colleagues (Wynter et al., 2021).

Patient satisfaction

Studies considering the patient satisfaction of care related to EMR implementation were rare. One such study was conducted at a large urban primary care sexual health Centre in 2013 by Fairley et al. and found

that patient satisfaction of their care was unchanged following EMR implementation. Given the increasing emphasis of the consumer viewpoint in healthcare transformation (Australian Commission on Safety and Quality in Health Care, 2022), one would expect to see this perspective being captured in future EMR research.

Medication safety

This scoping review identified EMRs almost eliminate certain types of medication errors such as error-prone abbreviations (EPAs), omitted doses, and errors related to clarity of prescriptions (McLain et al., 2017; Qian et al., 2015; Van de Vreede et al., 2018). However, they introduce other errors, such as incorrect patient selection and incorrect dose scheduling resulting in dose duplication (Van de Vreede et al., 2018).

Several authors state EMR design changes could help mitigate some of these new errors by modifying drop-down lists, for example. The same authors argued that electronic systems help identify errors easier than paper-based systems, which can drive quality and safety improvement projects (Qian et al., 2015; Van de Vreede et al., 2018).

McLain et al., (2017) highlighted national medication audit criteria needs to be adapted to electronic systems, as the current criteria were designed for paper-based systems and fall short in areas assessing EMRs. Since the publication of this research the Australian Commission on Safety and Quality in Health Care (ACSQHC) have revised their audit criteria, but are still not suitable for auditing of EMRs (Australian Commission on Safety and Quality in Health Care, 2018). The ACSQHC have, however, published guidance on display of on-screen medicines information (Australian Commission on Safety and Quality in Health Care, 2017), and have also produced a comprehensive guide to safe implementation of EMRs (Australian Commission on Safety and Quality in Health Care, 2019).

Reliability was compromised in some of these studies when mixed paper and electronic medication systems were in use (Dabliz et al., 2021; Qian et al., 2015).

Regulatory requirements

One study reported on EMRs as contributing to compliance with Residential Aged Care Accreditation standards (Jiang et al., 2016). However, the link between accreditation and patient safety and quality of care has recently been contested (Duckett, 2018a).

Workforce factors

Workforce satisfaction

Different user groups reported different levels of satisfaction with EMRs (Baysari et al., 2019; Dabliz et al., 2021; Lloyd, 2021; Schwarz et al., 2020; Wynter et al., 2021).

Nurses generally had positive acceptance for EMRs (Dabliz et al., 2021; Fairley et al., 2013; Lloyd, 2021; E. N. Munyisia et al., 2012; Van de Vreede et al., 2018), whereas pharmacists and medical staff were more likely to report issues with automation (Dabliz et al., 2021), safety risks (Van de Vreede et al., 2018), and increased workload (Baysari et al., 2019).

Baysari and colleagues (2019) discovered pharmacists are often the cohort teaching other healthcare staff how to use the system and reviewing additional information as part of a changed workload. This can increase stress and anxiety amongst the pharmacy workforce (Baysari et al., 2019).

This led to the recommendation that further research targeting different user groups is vital to target education and improve user experience pathways (Dabliz et al., 2021; Lloyd, 2021).

Sample sizes were a common limitation in this topic (Baysari et al., 2019; Lloyd, 2021; Schwarz et al., 2020; Wynter et al., 2021), as was lack of generalizability due to system brand (Baysari et al., 2019; Dabliz et al., 2021; Fairley et al., 2013).

Usability

Usability varies between user groups due to their workflows. Nurses and medical professionals have different experiences with EMR usability, which also depends on the area of work and which feature is measured. This often hinders generalizability of findings (Lloyd et al., 2021).

Greatest usability issues were related to protocol-mandated care, whereby if a user wanted to order outside of an order set, for example, this created difficulty (Dabliz et al., 2021).

Well-designed user interfaces can ‘... reduce the mental energy required searching for important information and the time taken to achieve this, (Dabliz et al., 2021) whereas poorly designed interfaces were associated with increased levels of dissatisfaction and longer times to perform tasks (E. N. Munyisia et al., 2012).

Both Lloyd et al., and Dabliz et al., (2021) advocate the need for multidisciplinary usability studies to represent different user groups and their associated environment.

Lloyd et al., (2021) promotion the use of the NuHISS tool to measure usability of EMRs in the Australian context.

When an interface is less than optimal, all research in this area highlighted the need for continuous improvement, utilizing lessons learned, and support for staff (Dabliz et al., 2021; Lloyd et al., 2021; E. N. Munyisia et al., 2012).

Limitations

The limitations of this study were that only English language papers were included due to the assumption Australian research would be conducted and published in the English language. There is a very small possibility that researchers have assessed EMR implementation in the Australian context but have published in another language.

Grey literature, scoping and systematic reviews were also excluded based on constraints and compatibility with the quality checklist used, meaning valuable industry data could have been missed.

Only a single researcher with a time constraint of 14 weeks was able to perform this scoping review. Hence personal researcher bias cannot be excluded from this study.

The MMAT checklist was used as a broad indicator of quality to contribute to answering the research question. Grading literature is not within the typical methodology of scoping reviews, so should be interpreted with caution (PRISMA, 2021; Rethlefsen et al., 2021; Subbe et al., 2021)

Conclusion

This is the first scoping review, to the author’s knowledge, to systematically determine how EMR implementation is evaluated in the Australian context. This is in response to government reports exposing a current lack of evaluation frameworks to assess EMRs, and the fact that EMRs are a relatively new addition to the Australian healthcare system compared to other nations, primarily occurring over the past decade (Duckett, 2018a; Jedwab et al., 2019). Previous reviews have often either focused on a particular topic (Subbe et al., 2021) or workforce group (Jedwab et al., 2019), and refer to international data, which is often stated as a limitation and/or knowledge gap in these studies.

This scoping review rigorously analysed the literature and out of the 25 articles found, the themes that were most evident were in quality and safety, and service delivery, though in recent years there has been an increase in studies reporting on workforce factors (satisfaction and usability). Workforce factors have been identified as important by authors such as Lloyd et al (2021) and Dabliz et al (2021), since different workforce groups are likely to report different outcomes.

Studies overall were mostly qualitative in nature, with only 16% being mixed methods, and just over a third being quantitative. Only seven of the 25 shortlisted articles were pre-post studies, reflecting the difficulty in designing and implementing such studies.

To date, most health workforce groups have been evenly represented, though there is limited research on how EMRs affect midwives and allied health professionals.

The system in use was not consistently referenced in the literature. If it was, the brand was most likely to be Cerner (Millennium). The differing brands of EMRs were cited as common limitations in most studies, restricting generalisability. Generalisability was also often restricted due to the specialty and/or setting under scrutiny.

Healthcare is a complex system, with multiple disciplines and workstreams. EMRs traverse all these systems, yet there is no consistent framework to determine if EMRs present value for money, or indeed improve patient care. An evaluative framework which incorporates one or more validated tools such as the WOMBAT or STAMP for time and motion studies, and NuHISS for user experience could be a recommendation.

This review solidifies the following benefits of EMRs:

- They provide a huge advantage regarding legibility and ease of access of patient records. This can reduce errors associated with paper records, including poor readability and abbreviation prone errors.
- EMRs have been shown to generally improve efficiency of multiple workflows, except for pharmacists.
- Most worker dissatisfaction with EMRs was related to change management and the EMR interface, though this varied across disciplines.

Research gaps include lack of patient viewpoint, non-medication-related patient safety outcomes (e.g. mortality rate, improvements in clinical outcomes), and how usability and EMR design impacts patient outcomes.

This review highlights the need to address the above research gaps, and to ultimately design uniform and validated outcome measures and frameworks to drive consistency across EMR evaluations. This will ensure benefits are tracked, realized, and maintained. Overall, the articles in this scoping review provide evidence to support the continued rollout of EMR systems across Australia, and have even drawn parallels with international findings (Lloyd, 2021; Westbrook et al., 2019). This indicates Australian policymakers could rely on international evidence, as well as that conducted in Australia. Whether the current selection of evidence is sufficient to guide policy or digital strategy in Australian healthcare remains to be seen.

Future research

Future research could be to use the same thematic analysis applied to global literature (for example, the U.S & Canada), and compare with findings of this study to determine if outcomes and themes are the same. This would permit the scientific community to apply with more certainty non-Australian research to Australian healthcare settings, and would also allow researchers to determine the proportion of Australian evidence in relation to the worldwide evidence base.

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Appendices

Appendix 1: List of search term combinations

Between each keyword the “AND” Boolean operator was used. For example, the first line search term entered into the search engine would be EMR AND Evaluat* AND Australia*. Similarly, the fifth line would read EMR AND “outcome measure” AND Australia*.

EMR Evaluat* Australia*

EMR success Australia*
EMR adopt* Australia*
EMR outcome* Australia*
EMR outcome measure* Australia*
EMR performance measure Australia*
EMR impact assess* Australia*
EMR monitor Australia*
EMR success rate Australia*
EMR perception Australia*
EMR key performance indicator* Australia*
EMR KPI* Australia*
EMR impact* Australia*
EMR measure* Australia*
EMR result* Australia*
EMR positive Australia*
EMR reduc* Australia*
EMR error* Australia*
EMR error rate Australia*
electronic medical record* Evaluat* Australia*
electronic medical record* success Australia*
electronic medical record* adopt* Australia*
electronic medical record* outcome* Australia*
electronic medical record* outcome measure* Australia*
electronic medical record* performance measure Australia*
electronic medical record* impact assess* Australia*
electronic medical record* success Australia*
electronic medical record* monitor Australia*
electronic medical record* success rate Australia*
electronic medical record* perception Australia*
electronic medical record* key performance indicator* Australia*
electronic medical record* KPI* Australia*
electronic medical record* impact* Australia*
electronic medical record* measure* Australia*
electronic medical record*benefit* Australia*
electronic medical record* positive Australia*
electronic medical record* reduc* Australia*
electronic medical record* error* Australia* implement*
electronic medical record* efficiency* Australia* implement*
electronic medical record* error rate Australia*
EHR Evaluat* Australia*
EHR success Australia*
EHR adopt* Australia*

EMR Evaluat* Australia*

EHR outcome* Australia*

EHR outcome measure* Australia*

EHR performance measure Australia*

EHR impact assess* Australia*

EHR success Australia*

EHR monitor Australia*

EHR success rate Australia*

EHR perception Australia*

EHR key performance indicator* Australia*

EHR KPI* Australia*

EHR impact* Australia*

EHR measure* Australia*

EHR result* Australia*

EHR positive Australia*

EHR reduc* Australia*

EHR error* Australia*

EHR error rate Australia*

electronic health record Evaluat* Australia*

electronic health record success Australia*

electronic health record adopt* Australia*

electronic health record outcome* Australia*

electronic health record outcome measure* Australia*

electronic health record performance measure Australia*

electronic health record impact assess* Australia*

electronic health record success Australia*

electronic health record monitor Australia*

electronic health record success rate Australia*

electronic health record perception Australia*

electronic health record key performance indicator* Australia*

electronic health record KPI* Australia*

electronic health record impact* Australia*

electronic health record measure* Australia*

electronic health record result* Australia*

electronic health record positive Australia*

electronic health record reduc* Australia*

electronic health record error* Australia*

electronic health record error rate Australia*

digital health record Evaluat* Australia*

digital health record success Australia*

digital health record adopt* Australia*

digital health record outcome* Australia*

digital health record outcome measure* Australia*

digital health record performance measure Australia*

digital health record impact assess* Australia*

digital health record success Australia*

digital health record monitor Australia*

digital health record success rate Australia*

digital health record perception Australia*

digital health record key performance indicator* Australia*

digital health record KPI* Australia*

EMR Evaluat* Australia*

digital health record impact* Australia*
digital health record measure* Australia*
digital health record result* Australia*
digital health record positive Australia*
digital health record reduc* Australia*
digital health record error* Australia*
digital health record error rate Australia*
EPR Evaluat* Australia*
EPR success Australia*
EPR adopt* Australia*
EPR outcome* Australia*
EPR outcome measure* Australia*
EPR performance measure Australia*
EPR impact assess* Australia*
EPR success Australia*
EPR monitor Australia*
EPR success rate Australia*
EPR perception Australia*
EPR key performance indicator* Australia*
EPR KPI* Australia*
EPR impact* Australia*
EPR measure* Australia*
EPR result* Australia*
EPR positive Australia*
EPR reduc* Australia*
EPR error* Australia*
EPR error rate Australia*
electronic patient record Evaluat* Australia*
electronic patient record success Australia*
electronic patient record adopt* Australia*
electronic patient record outcome* Australia*
electronic patient record outcome measure* Australia*
electronic patient record performance measure Australia*
electronic patient record impact assess* Australia*
electronic patient record success Australia*
electronic patient record monitor Australia*
electronic patient record success rate Australia*
electronic patient record perception Australia*
electronic patient record key performance indicator* Australia*
electronic patient record KPI* Australia*
electronic patient record impact* Australia*
electronic patient record measure* Australia*
electronic patient record result* Australia*
electronic patient record positive Australia*
electronic patient record reduc* Australia*
electronic patient record error* Australia*
electronic patient record error rate Australia*
electronic medication management system* Australia*

Appendix 2: Completed PRISMA-ScR Checklist (overleaf)

Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) Checklist

SECTION	ITEM	PRISMA-ScR CHECKLIST ITEM	REPORTED ON PAGE #
TITLE			
Title	1	Identify the report as a scoping review.	4 (not on title)
ABSTRACT			
Structured summary	2	Provide a structured summary that includes (as applicable); background, objectives, eligibility criteria, sources of evidence, charting methods, results, and conclusions that relate to the review questions and objectives.	4
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known. Explain why the review questions/objectives lend themselves to a scoping review approach.	4-8
Objectives	4	Provide an explicit statement of the questions and objectives being addressed with reference to their key elements (e.g., population or participants, concepts, and context) or other relevant key elements used to conceptualize the review questions and/or objectives.	4-8
METHODS			
Protocol and registration	5	Indicate whether a review protocol exists; state if and where it can be accessed (e.g., a Web address); and if available, provide registration information, including the registration number.	9
Eligibility criteria	6	Specify characteristics of the sources of evidence used as eligibility criteria (e.g., years considered, language, and publication status), and provide a rationale.	9-10
Information sources*	7	Describe all information sources in the search (e.g., databases with dates of coverage and contact with authors to identify additional sources), as well as the date the most recent search was executed.	9-11, 42-45
Search	8	Present the full electronic search strategy for at least 1 database, including any limits used, such that it could be repeated.	10-11, 42-45
Selection of sources of evidence†	9	State the process for selecting sources of evidence (i.e., screening and eligibility) included in the scoping review.	10-11
Data charting process‡	10	Describe the methods of charting data from the included sources of evidence (e.g., calibrated forms or forms that have been tested by the team before their use, and whether data charting was done independently or in duplicate) and any processes for obtaining and confirming data from investigators.	11
Data items	11	List and define all variables for which data were sought and any assumptions and simplifications made.	8-11, 42-45
Critical appraisal of individual sources of evidence§	12	If done, provide a rationale for conducting a critical appraisal of included sources of evidence; describe the methods used and how this information was used in any data synthesis (if appropriate).	9, 32
Synthesis of results	13	Describe the methods of handling and summarizing the data that were charted.	11



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SECTION	ITEM	PRISMA-ScR CHECKLIST ITEM	REPORTED ON PAGE #
RESULTS			
Selection of sources of evidence	14	Give numbers of sources of evidence screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally using a flow diagram.	11
Characteristics of sources of evidence	15	For each source of evidence, present characteristics for which data were charted and provide the citations.	20-27
Critical appraisal within sources of evidence	16	If done, present data on critical appraisal of included sources of evidence (see item 12).	20-27
Results of individual sources of evidence	17	For each included source of evidence, present the relevant data that were charted that relate to the review questions and objectives.	20-27
Synthesis of results	18	Summarize and/or present the charting results as they relate to the review questions and objectives.	12-27
DISCUSSION			
Summary of evidence	19	Summarize the main results (including an overview of concepts, themes, and types of evidence available), link to the review questions and objectives, and consider the relevance to key groups.	28-31
Limitations	20	Discuss the limitations of the scoping review process.	31
Conclusions	21	Provide a general interpretation of the results with respect to the review questions and objectives, as well as potential implications and/or next steps.	32-33
FUNDING			
Funding	22	Describe sources of funding for the included sources of evidence, as well as sources of funding for the scoping review. Describe the role of the funders of the scoping review.	9

JBI = Joanna Briggs Institute; PRISMA-ScR = Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews.
 * Where *sources of evidence* (see second footnote) are compiled from, such as bibliographic databases, social media platforms, and Web sites.
 † A more inclusive/heterogeneous term used to account for the different types of evidence or data sources (e.g., quantitative and/or qualitative research, expert opinion, and policy documents) that may be eligible in a scoping review as opposed to only studies. This is not to be confused with *information sources* (see first footnote).
 ‡ The frameworks by Arksey and O'Malley (6) and Levac and colleagues (7) and the JBI guidance (4, 5) refer to the process of data extraction in a scoping review as data charting.
 § The process of systematically examining research evidence to assess its validity, results, and relevance before using it to inform a decision. This term is used for items 12 and 19 instead of "risk of bias" (which is more applicable to systematic reviews of interventions) to include and acknowledge the various sources of evidence that may be used in a scoping review (e.g., quantitative and/or qualitative research, expert opinion, and policy document).

From: Tricco AC, Lillie E, Zarin W, O'Brien KK, Colquhoun H, Levac D, et al. PRISMA Extension for Scoping Reviews (PRISMA-ScR): Checklist and Explanation. *Ann Intern Med.* 2018;169:467-473. doi: 10.7326/M18-0950.

