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BMJ Open

Protocol for a scoping review to understand the role of inter-organisational electronic health records in changing clinical practice

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Manuscripts

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3 **Protocol for a scoping review to understand the role of inter-organisational**
4 **electronic health records in changing clinical practice**
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21 Keywords: Scoping review, decision making, clinical decision-making, decision making,
22 computer-assisted, health care quality assurance, organizational efficiency, computerized
23 medical records systems, electronic health records, hospital information systems, health
24 information exchange
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27 Word count, excluding title page, abstract, references: 1920
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ABSTRACT

Introduction:

Patient records are often fragmented across organizations and departments in UK health and care services, often due to sub-standard information technology. However, although government policy in the UK and internationally is strongly pushing “digital transformation”, the actual research evidence for the positive impact of electronic information systems on cost, quality and safety of healthcare is far from clear. In particular, the mechanisms by which information availability is translated into better decision-making are not well understood. We do not know when a full inter-organisational record is more useful than a key information summary or an institutional record. In this paper, we describe our scoping review of the mechanisms of action of inter-organisational electronic health records on clinical decision-making.

Methods and analysis:

This scoping review will follow the Arksey and O'Malley (2005) methodology. The review has adopted sociotechnical systems thinking and the notion of distributed cognition as its guiding conceptual models. The PubMed database will be searched and a hand search will be conducted using the reference lists of included studies to identify additional relevant articles. A two-part study selection process will be used: (a) a title and abstract review and (b) full text review. During the first step, two researchers separately will review the citations yielded from the search to determine eligibility based on the defined inclusion and exclusion criteria. Related articles will be included if they are empirical studies that address how inter-organisational records are used in clinical decision-making.

Ethics and dissemination:

The results of the review will be disseminated through stakeholder meetings, conference presentations and peer-reviewed publication. The data used in this review are from publicly available secondary sources, so this study does not require ethical review.

ARTICLE SUMMARY

Strengths and limitations of this study

- This is a novel review to understand the role of inter-organisational electronic health records in changing clinical practice.
- This review will extend the use of the Distributed Cognition for Teamwork – Concentric Layers (DiCoT-CL) framework to secondary research.
- Stakeholders including hospital clinicians, general practitioners, IT leadership and patient and public representatives will be involved throughout the study.
- The identification and synthesis of data will be limited to peer-reviewed published literature found in PubMed.

INTRODUCTION

In the current UK National Health Service (NHS) and social care, patient and service user information is fragmented across organisations and departments. Frequently, only the person or their carer knows where the various pockets of data about them or their loved ones are hidden away [1]. This is sometimes due to poor implementation of information technology [2] and sometimes due to the implementation of poor information technology [3, 4]. In an era of rising patient and treatment complexity from population ageing, multimorbidity, therapeutic advances and sub-specialisation of care, it is in principle reasonable to aim for integrated patient records across health and care to enable more effective and efficient decision-making.

Health and care services are sometimes painted as digital innovation “laggards” compared to industries like banking, retail and transport. Although many UK health services have been digital for years, such as general practice, pathology laboratories and diagnostic imaging, the level of sustained digital investment in other sectors is well known to have been massively higher over many decades than in health (at least in this country) [5]. Also, the culture and structure of the NHS does not lend itself to a top-down digital transformation (as the failed NHS Connecting for Health programme demonstrated so tragically) [2, 6].

Although government policy in the UK and internationally is strongly pushing “digital transformation”, the overall evidence for the impact of electronic information systems on cost, quality and safety of healthcare remains contested [7, 8]. Interpretation of the conflicting evidence base is split between aspirational “believers” [9] and more cautious evaluators [5, 10].

STUDY RATIONALE

Whilst it seems intuitively obvious that having better information about a patient will improve care, the mechanisms by which information availability is translated into better decision-making are not well understood [11]. Furthermore, there is the risk of information overload creating a negative outcome [12]. There are situations where a summary can be more useful than a rich record [13], but we do not have a clear synthesis of when or how a full inter-organisational record is more useful than a key information summary or an institutional record.

Inter-organisational electronic health records projects are widely implemented in several countries, with the aim to improve the quality of care and reduce costs. However, the literature on their evaluation post-implementation is still sparse [14, 15]. This scoping review aims to help understand how inter-organisational electronic health records can support improvements in direct patient care and how this can inform regional and national information strategies for policymakers.

STUDY OBJECTIVES

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3 The objective of this scoping review is to identify, categorise, summarise and synthesise
4 knowledge about the mechanisms of action of inter-organisational electronic health records
5 on clinical decision-making.
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7 **METHODS AND ANALYSIS**

8 **Theoretical frameworks**

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11 This scoping review has adopted sociotechnical systems thinking [16] and in particular the
12 notion of distributed cognition [17] as its guiding conceptual models. Sociotechnical systems
13 thinking examines the “dynamic, mutual influences among the social subsystem (people,
14 tasks, relationships), the technical subsystem (technologies, techniques, task performance
15 methods, work settings), and their social and organizational environments” [18]. It provides
16 the fundamental insights that a technical system inevitably affects and is affected by the
17 interdependent social system within which and upon which it operates [19] and that the
18 sociotechnical system is adaptive and complex (that is, subject to emergent change, not
19 merely complicated) [20]. Distributed cognition has been defined as a paradigm that
20 “locates thought as an emergent property of people interacting with other actors and the
21 environment rather than a process inherently restricted to individual minds” [21]. In
22 contrast to classical cognitive theory that is constrained to “what goes on in the head”,
23 distributed cognition describes what goes on “in the world” as an interactive cognitive
24 system comprising people, artefacts and environments, and explores “how information
25 processing is coordinated in sociotechnical systems” [22].
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32 Specifically, the review will use the framework called Distributed Cognition for Teamwork –
33 Concentric Layers (DiCoT-CL) [22], shown in Figure 1 (based on [22], adapted with
34 permission). The idea of the concentric circles draws upon Grudin’s description of
35 technology “reaching out” through layers of context or abstraction [23]. The framework
36 encompasses five sub-models: information flow, artefact, physical, social and evolutionary
37 [24]. Although it was primarily developed to support primary research into teams within a
38 single context, we propose to use the framework to guide our analysis and categorisation of
39 the literature across multiple contexts and study types that consider both individual and
40 team decision-making using shared EHRs. We hypothesise that the framework, given its
41 description as leaning towards “looser use” where the “boundaries could bend and blur”
42 [22], will have the flexibility to cope with this extended application for secondary research.
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49 **Figure 1 – Distributed Cognition for Teamwork – Concentric Layers (DiCoT-CL) (adapted 50 from [22] with permission)**

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52 We shall also explore whether it is feasible to combine insights from this framework with
53 any evidence we find that relates to Coiera’s notion of the “information value chain”. The
54 value chain (Figure 2, reproduced from [25]) might be conceived as a path traversing the
55 DiCoT-CL layers or as an independent axis.
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Figure 2 – Information value chain (reproduced from [25] with permission)

Protocol design

This study follows the Arksey and O'Malley (2005) scoping review methodology, and various updates [26, 27]. This methodology consists of five stages: (1) identifying the research question(s); (2) identifying potentially relevant studies; (3) selecting eligible studies; (4) charting the data; (5) collating, summarising and reporting the results. This protocol has been submitted to PROSPERO (ID 94391).

Patient and Stakeholder Involvement

This review is the first stage of a project which will continue with primary qualitative research into how clinicians actually use a particular inter-organisational patient record. The population of interest is physicians and clinical pharmacists, given that many care decisions are about adding, stopping or changing doses of medications. We have formed a patient and public involvement (PPI) group to advise the entire project, including the scoping review. The review proposals have been discussed with the project PPI group and with a regional Young Adults PPI group (YAPPI) organized by the South Central Research Design Service (RDS) of the National Institute for Health Research (NIHR). The project has a steering group with representation from hospital clinicians, general practitioners and the IT leadership.

Stage 1: Identifying the research questions

Arksey and O'Malley [28] propose that an iterative process is required in order to formulate the research question(s) and that this will help the researchers to familiarise themselves with the literature. Our research questions were developed and refined through an iterative process and consultations held by the research team. This review will be guided by the main broad research question: (RQ1) "How do inter-organisational electronic health and care records affect clinical decision-making?"

Given the scope of our primary research that will follow this review, the term "clinical" in our main research question relates to physicians and clinical pharmacists.

Furthermore, two secondary research questions will be used to guide this review: (RQ2) "When are rich electronic health records more useful than summary records?" and (RQ3) "What specific pathways or protocols demonstrate cost reduction or quality improvement (QI) from inter-organisational electronic health records?"

Stage 2: Identifying relevant studies

Based on preliminary searches, the research team will identify and refine eligibility criteria and the formulation of the search strategy and search terms. The currently proposed search strategy is shown in online supplementary appendix 1. This will be refined as required to

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3 ensure the inclusion of all the relevant studies from the literature. Search results will be
4 downloaded and imported into Microsoft Excel for further analysis.
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6 Given the scope of “clinician” defined in this review (see under Patient Involvement and
7 Stage 1), we have selected to only use the PubMed database. Furthermore, hand searches
8 will be conducted using the references lists of the included studies in order to identify
9 additional relevant articles. Articles will be included if they are empirical studies that
10 address how inter-organisational electronic health records or health information exchange
11 are used in clinical decision-making. Studies will be excluded if they are discussing the
12 technical aspect of designing electronic health records, health information exchange or the
13 clinical decision support systems embedded in electronic health records. Studies will also be
14 excluded if they address electronic health records or clinical decision support systems within
15 a single organisation.
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20 **Stage 3: Study selection**

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22 A two-part study selection process will be used: (a) a title and abstract review and (b) full
23 text review. Inter-rater reliability will be calculated for both stages using Cohen’s kappa to
24 iteratively calibrate and refine the process. In the first step, two reviewers will separately
25 review the citations yielded from the search to determine the eligibility based on the
26 defined inclusion and exclusion criteria. To confirm their robustness, the inclusion and
27 exclusion criteria will be tested on a sample of abstracts before conducting the actual search
28 to help capture any studies that may be relevant to inter-organisational electronic health
29 records. All the articles which are considered relevant by either or both reviewers will be
30 included in the full-text review.
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34 In the second step, two reviewers will independently evaluate the full-text articles to decide
35 if they meet the inclusion/exclusion criteria. In case of any disagreement about inclusion,
36 full-text articles will be reviewed again by both reviewers and if an agreement cannot be
37 reached, this will be resolved by a consolidation with an independent third reviewer [29].
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40 **Stage 4: Charting the data**

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42 The fourth stage of Arksey and O'Malley [28] scoping review methodology is the charting
43 the data of the selected articles. A data extraction form will be developed by the reviewers
44 to help in deciding the relevance of the study. During this stage, key information about the
45 selected articles will be collected (for example, author(s), year of publication, country,
46 objectives of the study, methods, findings). The data extraction form will be reviewed by the
47 research team and our stakeholders (steering group and PPI representatives). In order to
48 ensure the validity of the data extraction form, it will be piloted by both reviewers before
49 conducting the actual searches. After the actual searches have been executed, the data
50 extraction will be subjected to a test by both reviewers separately extracting the data from
51 a sample of the included articles. The sample size will be calculated once the total number
52 included is known [26]. Subject to the outcome of this test and the volume of included
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papers, the team will determine whether complete independent extraction is necessary if it can be performed separately.

Stage 5: Collating, summarising and reporting the results

As a scoping review, the purpose of this study is to aggregate the findings and present an overview of the research rather than evaluating the quality of the individual studies. The Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) guidelines will be followed [30] to accurately report the review results and analysis. We will use the DiCoT-CL framework and the information value chain concept to help to categorise and synthesise the literature. The results of the review will be disseminated through stakeholder meetings, conference presentations and peer-reviewed publication. The data used in this review are from publicly available secondary sources, so this study does not require ethical review.

Author contributions

PS conceived the study and outlined the protocol. PS and HN jointly developed the research questions and drafted the paper. PR revised the paper. All authors further revised the paper and approved the final text.

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Competing interests

None.

Data sharing statement

No additional data are currently available.

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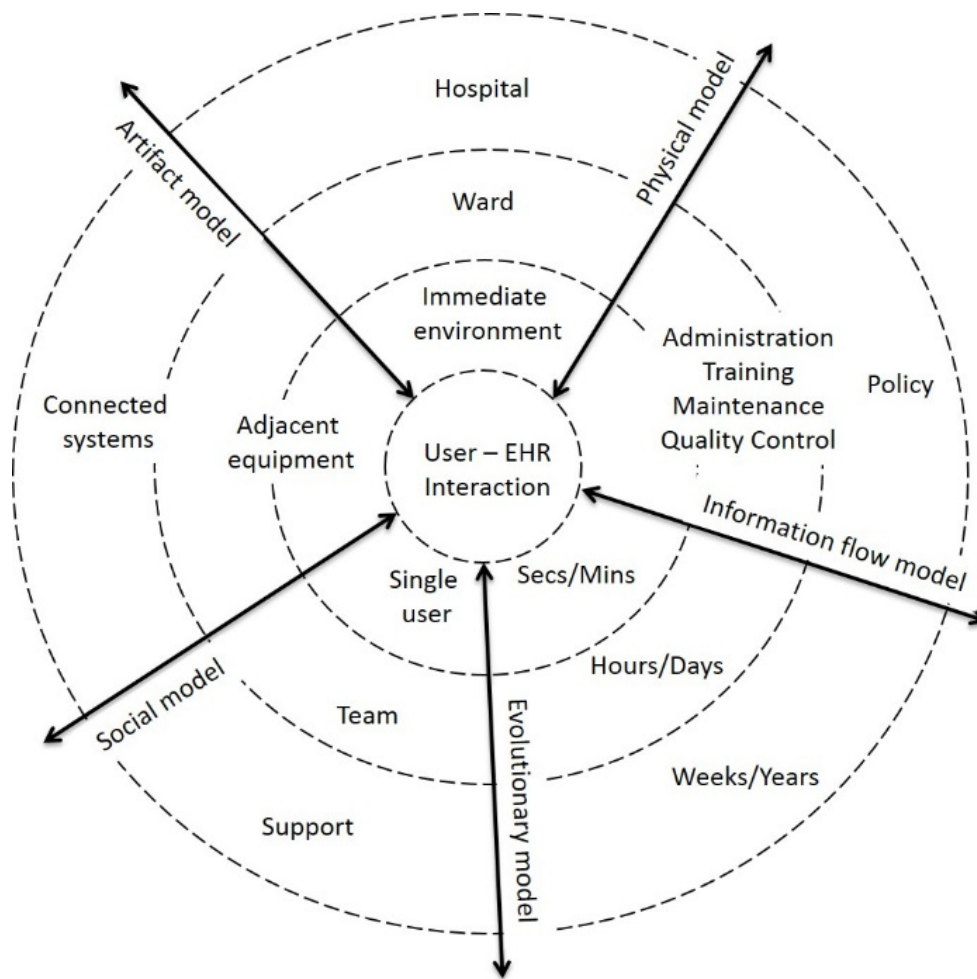


Figure 1 – Distributed Cognition for Teamwork – Concentric Layers (DiCoT-CL) (adapted from [22] with permission)

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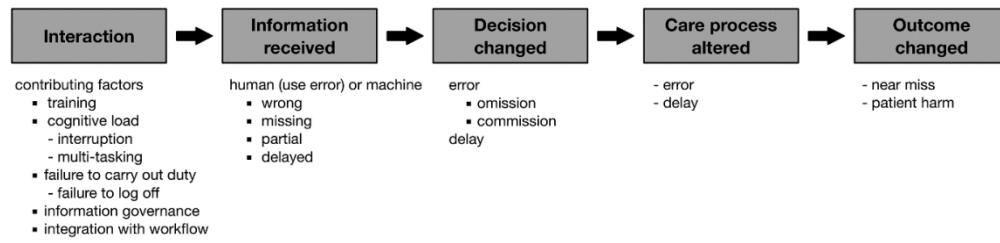


Figure 2 – Information value chain (reproduced from [25] with permission)

159x36mm (220 x 220 DPI)

Appendix 1- Proposed search strategy

Strategy number 1	Search terms /description
1	("Decision Making"[Mesh] OR "Clinical Decision-Making"[Mesh] OR "Decision Making, Computer-Assisted"[Mesh] OR "Quality Assurance, Health Care"[MeSH] OR "Efficiency, Organizational"[MeSH]) AND ("Medical Records Systems, Computerized"[Mesh] OR "Electronic Health Records"[Mesh] OR "Hospital Information Systems"[Mesh] OR "Health Information Exchange"[Mesh]) AND (hasabstract[text] AND "loattrfull text"[sb] AND ("2008/04/19"[PDat] : "2018/04/16"[PDat]) AND "humans"[MeSH Terms] AND English[lang])
2	A manual search in the references lists of the included studies

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Primary Subject Heading:	Health informatics
Secondary Subject Heading:	Health services research, Communication, Diagnostics, Emergency medicine, Health economics
Keywords:	Health informatics < BIOTECHNOLOGY & BIOINFORMATICS, Quality in health care < HEALTH SERVICES ADMINISTRATION & MANAGEMENT, Information technology < BIOTECHNOLOGY & BIOINFORMATICS

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4 **records affect hospital physician and pharmacist decisions**
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22 Keywords: Scoping review, decision making, clinical decision-making, decision making, computer-
23 assisted, health care quality assurance, organizational efficiency, computerized medical records
24 systems, electronic health records, hospital information systems, health information exchange
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27 Word count, excluding title page, abstract, references: 2414
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ABSTRACT

Introduction:

Patient records are often fragmented across organizations and departments in UK health and care services, often due to sub-standard information technology. However, although government policy in the UK and internationally is strongly pushing “digital transformation”, the evidence for the positive impact of electronic information systems on cost, quality and safety of healthcare is far from clear. In particular, the mechanisms by which information availability is translated into better decision-making are not well understood. We do not know when a full inter-organisational record is more useful than a key information summary or an institutional record. In this paper, we describe our scoping review of how inter-organisational electronic health records affect decision-making by hospital physicians and pharmacists.

Methods and analysis:

This scoping review will follow the Arksey and O'Malley (2005) methodology. The review has adopted sociotechnical systems thinking and the notion of distributed cognition as its guiding conceptual models. The UK National Institute for Health and Care Excellence (NICE) Healthcare Databases Advanced Search (HDAS) will be used, as it incorporates key sources including PubMed, MEDLINE, EMBASE, HMIC and Health Business Elite. A hand search will be conducted using the reference lists of included studies to identify additional relevant articles. A two-part study selection process will be used: (a) a title and abstract review and (b) full text review. During the first step, two researchers separately will review the citations yielded from the search to determine eligibility based on the defined inclusion and exclusion criteria. Related articles will be included if they are empirical studies that address how inter-organisational records affect decision-making by hospital physicians and pharmacists.

Ethics and dissemination:

The results will be disseminated through stakeholder meetings, conference presentations and peer-reviewed publication. The data used are from publicly available secondary sources, so this study does not require ethical review.

ARTICLE SUMMARY

Strengths and limitations of this study

- This is a novel scoping review to understand how inter-organisational electronic health records affect hospital physician and pharmacist decision-making.
- This review will extend the use of the Distributed Cognition for Teamwork – Concentric Layers (DiCoT-CL) framework to secondary research.

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- Stakeholders including hospital clinicians, general practitioners, IT leadership and patient and public representatives will be involved throughout the study.
- The identification and synthesis of data will be limited to peer-reviewed published literature found in the NICE Healthcare Databases Advanced Search and snowball references.
- Our defined scope may exclude important aspects of the use of inter-organisational electronic health records, both for inpatient and ambulatory care.

INTRODUCTION

In the current UK National Health Service (NHS) and social care, patient and service user information is fragmented across organisations and departments. Frequently, only the person or their carer knows where the various pockets of data about them or their loved ones are hidden away [1]. This is sometimes due to poor implementation of information technology [2] and sometimes due to the implementation of poor information technology [3, 4]. In an era of rising patient and treatment complexity from population ageing, multi-morbidity, therapeutic advances and sub-specialisation of care, it is in principle reasonable to aim for integrated patient records across health and care to enable more effective and efficient decision-making.

Health and care services are sometimes painted as digital innovation “laggards” compared to industries like banking, retail and transport. Although many UK health services have been digital for years, such as general practice, pathology laboratories and diagnostic imaging, the level of sustained digital investment in other sectors is well known to have been massively higher over many decades than in health (at least in the UK) [5]. Also, the culture and structure of the NHS does not lend itself to a top-down digital transformation (as the failed NHS Connecting for Health programme demonstrated so tragically) [2, 6].

Although government policy in the UK and internationally is strongly pushing “digital transformation”, the overall evidence for the impact of electronic information systems on cost, quality and safety of healthcare remains contested [7, 8]. Interpretation of the conflicting evidence base is split between aspirational “believers” [9] and more cautious evaluators [5, 10].

STUDY RATIONALE

Whilst it seems intuitively obvious that having better information about a patient will improve care, the mechanisms by which information availability is translated into better decision-making are not well understood [11]. Furthermore, there is the risk of information overload creating a negative outcome [12]. There are situations where a summary can be more useful than a rich record [13], but we do not have a clear synthesis of when or how a full inter-organisational record is more useful than a key information summary or an institutional record.

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3 Inter-organisational electronic health records projects are widely implemented in several
4 countries, with the aim to improve the quality of care and reduce costs. However, the literature
5 on their evaluation post-implementation is still sparse [14, 15]. This scoping review aims to help
6 understand how inter-organisational electronic health records can support improvements in
7 direct patient care and how this can inform regional and national information strategies for
8 policymakers.
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12 The population of interest is hospital physicians and clinical pharmacists, as we are primarily
13 concerned with decisions relating to diagnosis and treatment.
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15 **STUDY OBJECTIVES**

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18 The objective of this scoping review is to identify, categorise, summarise and synthesise
19 knowledge about the mechanisms of action of inter-organisational electronic health records on
20 decision-making by hospital physicians and pharmacists. Inter-organisational electronic health
21 records take various forms [16]: some are static aggregations or repositories of data from
22 multiple institutional records [17] and others are virtual records dynamically assembled by
23 querying external distributed databases using either proprietary or standards-based semantic
24 interoperability [18, 19]. This review does not distinguish between these types of record, as the
25 focus is on the use of information in decision-making rather than the technical architecture.
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29 **METHODS AND ANALYSIS**

30 **Theoretical frameworks**

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33 This scoping review has adopted sociotechnical systems thinking [20] and in particular the notion
34 of distributed cognition [21] as its guiding conceptual models. Sociotechnical systems thinking
35 examines the “dynamic, mutual influences among the social subsystem (people, tasks,
36 relationships), the technical subsystem (technologies, techniques, task performance methods,
37 work settings), and their social and organizational environments” [22]. It provides the
38 fundamental insights that a technical system inevitably affects and is affected by the
39 interdependent social system within which and upon which it operates [23] and that the
40 sociotechnical system is adaptive and complex (that is, subject to emergent change, not merely
41 complicated) [24]. Distributed cognition has been defined as a paradigm that “locates thought as
42 an emergent property of people interacting with other actors and the environment rather than
43 a process inherently restricted to individual minds” [25]. In contrast to classical cognitive theory
44 that is constrained to “what goes on in the head”, distributed cognition describes what goes on
45 “in the world” as an interactive cognitive system comprising people, artefacts and environments,
46 and explores “how information processing is coordinated in sociotechnical systems” [26].
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54 Specifically, the review will use the framework called Distributed Cognition for Teamwork –
55 Concentric Layers (DiCoT-CL) [26], shown in Figure 1 (based on [26], adapted with permission).
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3 The idea of the concentric circles draws upon Grudin's description of technology "reaching out"
4 through layers of context or abstraction [27]. This might be interpreted as a "ripple effect"
5 spreading from the micro to the macro without any fixed boundary. The framework encompasses
6 five sub-models: information flow, artefact, physical, social and evolutionary [28]. Although it
7 was primarily developed to support primary research into teams within a single context, we
8 propose to use the framework to guide our analysis and categorisation of the literature across
9 multiple contexts and study types that consider both individual and team decision-making using
10 shared EHRs. We hypothesise that the framework, given its description as leaning towards
11 "looser use" where the "boundaries could bend and blur" [26], will have the flexibility to cope
12 with this extended application for secondary research.
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18 **Figure 1 – Distributed Cognition for Teamwork – Concentric Layers (DiCoT-CL) (adapted from**
19 **[26] with permission)**
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21 We shall also explore whether it is feasible to combine insights from this framework with any
22 evidence we find that relates to Coiera's notion of the "information value chain". The value chain
23 (Figure 2, reproduced from [29]) might be conceived as a path traversing the DiCoT-CL layers or
24 as an independent axis.
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28 **Figure 2 – Information value chain (reproduced from [29] with permission)**
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30 **Protocol design**

31 This study follows the Arksey and O'Malley (2005) scoping review methodology, and various
32 updates [30, 31]. This methodology consists of five stages: (1) identifying the research
33 question(s); (2) identifying potentially relevant studies; (3) selecting eligible studies; (4) charting
34 the data; (5) collating, summarising and reporting the results. This protocol was submitted to
35 PROSPERO, but not accepted for registration as they do not currently take scoping review
36 protocols. The Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA-P)
37 guidelines [32] have been followed (as far as relevant for a scoping review) to verify the structure
38 and content of this protocol (the checklist is available as a supplementary file).
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44 **Patient and Public Involvement**

45 This review is the first stage of a project which will continue with primary qualitative research
46 into how clinicians actually use a particular inter-organisational patient record. We have formed
47 a patient and public involvement (PPI) group to advise the entire project, including the scoping
48 review. The review proposals have been discussed with the project PPI group and with a regional
49 Young Adults PPI group (YAPPI) organized by the South Central Research Design Service (RDS) of
50 the National Institute for Health Research (NIHR). The PPI discussions confirmed that the
51 proposed scope was important and relevant to patients and that the approach was satisfactory.
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3 The project has a steering group with representation from hospital clinicians, general
4 practitioners, the NHS funding body and the IT leadership.
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6 **Stage 1: Identifying the research questions**

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8 Arksey and O'Malley [33] propose that an iterative process is required in order to formulate the
9 research question(s) and that this will help the researchers to familiarise themselves with the
10 literature. Our research questions were developed and refined through an iterative process and
11 consultations held by the research team. This review will be guided by the main broad research
12 question: (RQ1) "How do inter-organisational electronic health and care records affect decision-
13 making by hospital physicians and pharmacists?" This question was selected based on the scope
14 of our primary research that will follow this review. We are not presuming that all effects will be
15 positive or making that an inclusion criterion.
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21 Furthermore, two secondary research questions will be used to guide this review, with the same
22 implicit scope: (RQ2) "When are rich electronic health records more useful than summary
23 records?" and (RQ3) "What specific pathways or protocols demonstrate cost reduction or quality
24 improvement (QI) from inter-organisational electronic health records?"
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27 **Stage 2: Identifying relevant studies: search terms and inclusion/exclusion criteria**

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29 Based on preliminary searches, the research team will identify and refine eligibility criteria and
30 the formulation of the search strategy and search terms. The currently proposed initial search
31 strategy is shown in online supplementary appendix 1. The search has been limited to studies
32 published since 2008, but we anticipate locating older or seminal papers about inter-
33 organisational electronic health records through snowball referencing. This search strategy will
34 be iterated and refined as required to ensure the inclusion of all the relevant studies from the
35 literature. Search results will be downloaded and imported into Microsoft Excel for further
36 analysis.
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41 We have selected the UK National Institute for Health and Care Excellence (NICE) Healthcare
42 Databases Advanced Search (HDAS), as it incorporates key sources including PubMed, MEDLINE,
43 EMBASE, HMIC and Health Business Elite. Furthermore, hand searches will be conducted using
44 the reference lists of the included studies in order to identify additional relevant articles that may
45 not be directly indexed in HDAS sources.
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49 Articles will be included if they are empirical studies that address how inter-organisational
50 electronic health records or health information exchange are used in decision-making by hospital
51 physicians or pharmacists. Studies will be excluded if they are discussing the technical aspect of
52 designing electronic health records, health information exchange or the clinical decision support
53 systems embedded in electronic health records. Studies will also be excluded if they address
54 electronic health records or clinical decision support systems within a single organisation. The
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inclusion criteria defined by population, intervention, comparator and outcomes (PICO) is shown in Table 1.

Table 1 – Population, Intervention, Comparator, Outcomes

Population	Hospital physicians and pharmacists
Intervention	Inter-organisational electronic health records
Comparator	Usual practice without inter-organisational electronic health records
Outcomes	Any outcome relating to changed decisions or decision-making process in diagnosis and treatment

Stage 3: Study selection

A two-part study selection process will be used: (a) a title and abstract review and (b) full text review. Inter-rater reliability will be calculated for both stages using Cohen's kappa to iteratively calibrate and refine the process. In the first step, two reviewers will separately review the citations yielded from the search to determine the eligibility based on the defined inclusion and exclusion criteria. To confirm their robustness, the inclusion and exclusion criteria will be tested on a sample of abstracts before conducting the actual search to help capture any studies that may be relevant to inter-organisational electronic health records. All the articles which are considered relevant by either or both reviewers will be included in the full-text review.

In the second step, two reviewers will independently evaluate the full-text articles to decide if they meet the inclusion/exclusion criteria. In case of any disagreement about inclusion, full-text articles will be reviewed again by both reviewers and if an agreement cannot be reached, this will be resolved by a consolidation with an independent third reviewer [34].

Stage 4: Charting the data

The fourth stage of Arksey and O'Malley [33] scoping review methodology is the charting the data of the selected articles. A data extraction form will be developed by the reviewers to help in deciding the relevance of the study. During this stage, key information about the selected articles will be collected (for example, author(s), year of publication, country, objectives of the study, methods, findings). The data extraction form will be reviewed by the research team and our stakeholders (steering group and PPI representatives). In order to ensure the validity of the data extraction form, it will be piloted by both reviewers before conducting the actual searches. After the actual searches have been executed, the data extraction will be subjected to a test by both reviewers separately extracting the data from a sample of the included articles. The sample size will be calculated once the total number included is known [30]. Subject to the outcome of this test and the volume of included papers, the team will determine whether complete independent extraction is necessary or if it can be performed separately.

Stage 5: Collating, summarising and reporting the results

As a scoping review, the purpose of this study is to aggregate the findings and present an overview of the research rather than evaluating the quality of the individual studies. Our overall assessment of the strength of the evidence will therefore be narrative rather than quantitative. We will use the DiCoT-CL framework and the information value chain concept to help to categorise and synthesise the literature. We will also report our experience with the scoping review methodology and any suggestions for improvement that we might develop. The results of the review will be disseminated through stakeholder meetings, conference presentations and peer-reviewed publication. The data used in this review are from publicly available secondary sources, so this study does not require ethical review.

Limitations

We recognize that our defined scope, decision-making by hospital physicians or pharmacists, may exclude other important aspects of the use of inter-organisational electronic health records or health information exchange, both for inpatient and ambulatory care. However, this definition is in line with the nature of our planned primary research and therefore sufficient for the current study. We hope to extend this review with further work with a broader scope in due course.

Discussion

An evidence-based approach to “digital health” is still not the norm [5]. This scoping review aims to contribute to the health informatics evidence base by consolidating knowledge about the impacts of wider and richer information sharing upon diagnosis and treatment of hospital inpatients, using the theoretical lenses of distributed cognition and the information value chain. The review will inform our subsequent primary research and contribute useful insights for the design and implementation of future generations of health record.

Author contributions

PS conceived the study, outlined the protocol and is guarantor of the review. PS and HN jointly developed the research questions and drafted the paper. PR revised the paper. All authors further revised the paper and approved the final text. We gratefully acknowledge the helpful comments of our PPI advisers.

Funding

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Competing interests

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3 None.

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5 **Data sharing statement**

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7 No additional data are currently available.

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For peer review only

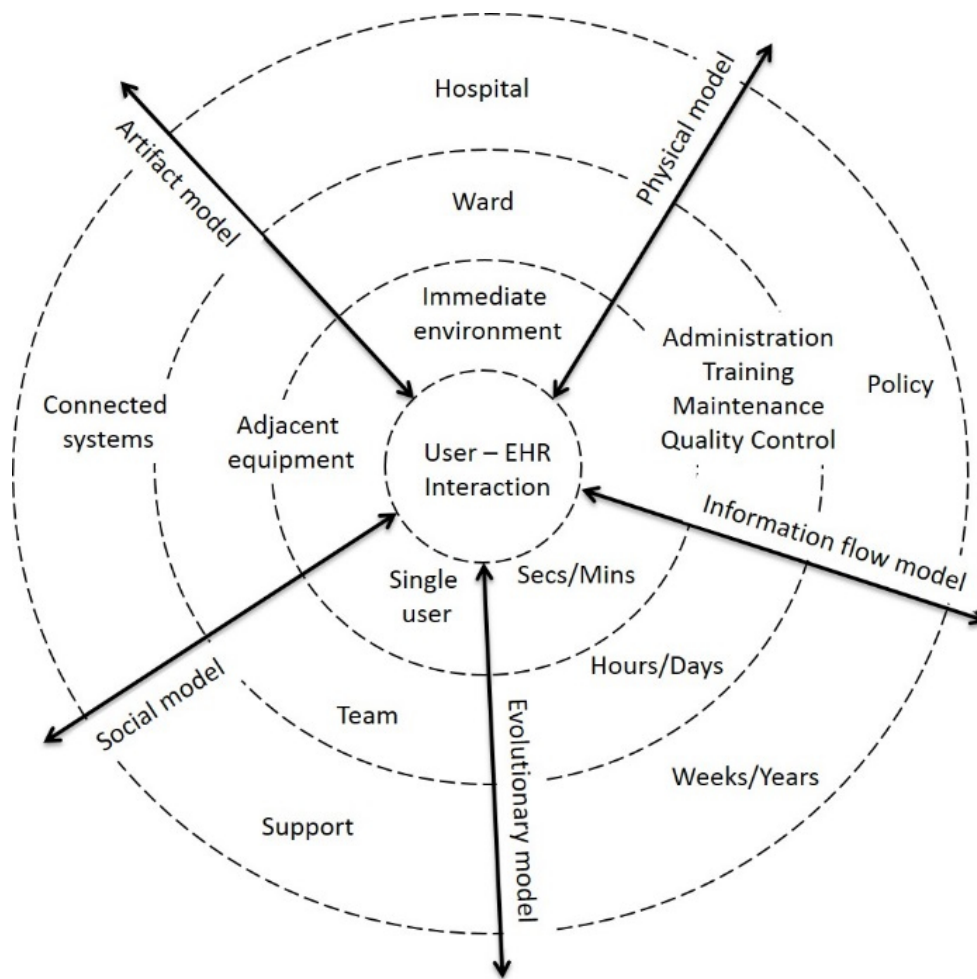


Figure 1 – Distributed Cognition for Teamwork – Concentric Layers (DiCoT-CL) (adapted from [26] with permission)

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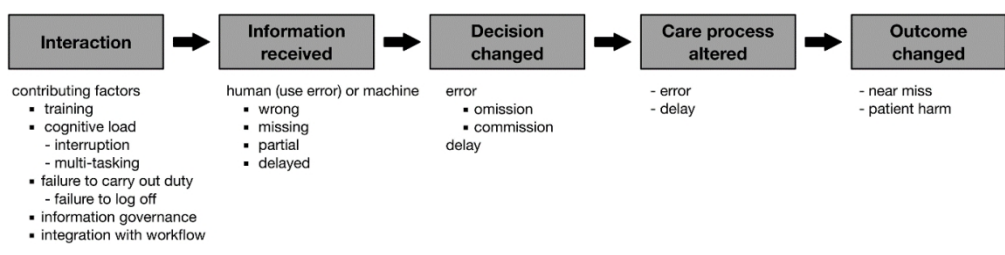


Figure 2 – Information value chain (reproduced from [29] with permission)

159x36mm (220 x 220 DPI)

PRISMA-P 2015 Checklist

This checklist has been adapted for use with protocol submissions to *Systematic Reviews* from Table 3 in Moher D et al: Preferred reporting items for systematic review and meta-analysis protocols (PRISMA-P) 2015 statement. *Systematic Reviews* 2015 4:1

Section/topic	#	Checklist item	Information reported		Line number(s)
			Yes	No	
ADMINISTRATIVE INFORMATION					
Title					
Identification	1a	Identify the report as a protocol of a systematic review	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
Update	1b	If the protocol is for an update of a previous systematic review, identify as such	<input type="checkbox"/>	<input type="checkbox"/>	N/A
Registration	2	If registered, provide the name of the registry (e.g., PROSPERO) and registration number in the Abstract	<input type="checkbox"/>	<input type="checkbox"/>	N/A
Authors					
Contact	3a	Provide name, institutional affiliation, and e-mail address of all protocol authors; provide physical mailing address of corresponding author	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
Contributions	3b	Describe contributions of protocol authors and identify the guarantor of the review	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
Amendments	4	If the protocol represents an amendment of a previously completed or published protocol, identify as such and list changes; otherwise, state plan for documenting important protocol amendments	<input type="checkbox"/>	<input type="checkbox"/>	N/A
Support					
Sources	5a	Indicate sources of financial or other support for the review	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
Sponsor	5b	Provide name for the review funder and/or sponsor	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
Role of sponsor/funder	5c	Describe roles of funder(s), sponsor(s), and/or institution(s), if any, in developing the protocol	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
INTRODUCTION					
Rationale	6	Describe the rationale for the review in the context of what is already known	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
Objectives	7	Provide an explicit statement of the question(s) the review will address with reference to participants, interventions, comparators, and outcomes (PICO)	<input checked="" type="checkbox"/>	<input type="checkbox"/>	

Section/topic	#	Checklist item	Information reported		Line number(s)
			Yes	No	
METHODS					
Eligibility criteria	8	Specify the study characteristics (e.g., PICO, study design, setting, time frame) and report characteristics (e.g., years considered, language, publication status) to be used as criteria for eligibility for the review	✓	<input type="checkbox"/>	
Information sources	9	Describe all intended information sources (e.g., electronic databases, contact with study authors, trial registers, or other grey literature sources) with planned dates of coverage	✓	<input type="checkbox"/>	
Search strategy	10	Present draft of search strategy to be used for at least one electronic database, including planned limits, such that it could be repeated	✓	<input type="checkbox"/>	
STUDY RECORDS					
Data management	11a	Describe the mechanism(s) that will be used to manage records and data throughout the review	✓	<input type="checkbox"/>	
Selection process	11b	State the process that will be used for selecting studies (e.g., two independent reviewers) through each phase of the review (i.e., screening, eligibility, and inclusion in meta-analysis)	✓	<input type="checkbox"/>	
Data collection process	11c	Describe planned method of extracting data from reports (e.g., piloting forms, done independently, in duplicate), any processes for obtaining and confirming data from investigators	✓	<input type="checkbox"/>	
Data items	12	List and define all variables for which data will be sought (e.g., PICO items, funding sources), any pre-planned data assumptions and simplifications	✓	<input type="checkbox"/>	
Outcomes and prioritization	13	List and define all outcomes for which data will be sought, including prioritization of main and additional outcomes, with rationale	✓	<input type="checkbox"/>	
Risk of bias in individual studies	14	Describe anticipated methods for assessing risk of bias of individual studies, including whether this will be done at the outcome or study level, or both; state how this information will be used in data synthesis	<input type="checkbox"/>	✓	
DATA					
Synthesis	15a	Describe criteria under which study data will be quantitatively synthesized	<input type="checkbox"/>	✓	
	15b	If data are appropriate for quantitative synthesis, describe planned summary measures, methods of handling data, and methods of combining data from studies, including any planned exploration of consistency (e.g., I^2 , Kendall's tau)	<input type="checkbox"/>	✓	
	15c	Describe any proposed additional analyses (e.g., sensitivity or subgroup analyses, meta-regression)	<input type="checkbox"/>	✓	
	15d	If quantitative synthesis is not appropriate, describe the type of summary planned	✓	<input type="checkbox"/>	

Section/topic	#	Checklist item	Information reported		Line number(s)
			Yes	No	
Meta-bias(es)	16	Specify any planned assessment of meta-bias(es) (e.g., publication bias across studies, selective reporting within studies)	<input type="checkbox"/>	<input checked="" type="checkbox"/>	
Confidence in cumulative evidence	17	Describe how the strength of the body of evidence will be assessed (e.g., GRADE)	<input checked="" type="checkbox"/>	<input type="checkbox"/>	

For peer review only

Appendix 1 - Proposed initial search strategy

Stage	Search terms /description
1	(("Decision-making" OR "Clinical decision-making" OR "Computer-assisted decision-making" OR "clinical decision support systems") AND ("Medical Records Systems, Computerized" OR "Electronic Health Records" OR "Hospital Information Systems" OR "Health Information Exchange")) Date range: 2008/01/01 -- 2018/01/01 English only
2	Manual search in the reference lists of the included studies
3	Iterative refinements of stage 1, adapting to variant indexing practice in HDAS sources