

Benefits and risks of structuring and/or coding the presenting patient history in the electronic health record: systematic review

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ABSTRACT

Background: Patient histories in electronic health records currently exist mainly in free text format thereby limiting the possibility that decision support technology may contribute to the accuracy and timeliness of clinical diagnoses. Structuring and/or coding make patient histories potentially computable.

Methods: A systematic review was undertaken of the benefits and risks of structuring and/or coding patient history by searching nine international databases for published and unpublished studies over the period 1990–2010. The focus was on the current patient history, defined as information reported by a patient or the patient's caregiver about the patient's present health situation and health status. Findings were synthesised through a theoretically based textual analysis.

Findings: Of the 9207 potentially eligible papers identified, 10 studies satisfied the eligibility criteria. There was evidence of a modest number of benefits associated with structuring the current patient history, including obtaining more complete clinical histories, improved accuracy of patient self-documented histories, and better associated decision-making by professionals. However, no studies demonstrated any resulting improvements in patient care or outcomes. When more detailed records were obtained through the use of a structured format no attempt was made to confirm if this additional information was clinically useful. No studies investigated possible risks associated with structuring the patient history. No studies examined coding of the patient history.

Conclusions: There is an insufficient evidence base for sound policy making on the benefits and risks of structuring and/or coding patient history. The authors suggest this field of enquiry warrants further investigation given the interest in use of decision support technology to aid diagnoses.

BACKGROUND

As use of electronic health record (EHR) systems becomes more widespread internationally,^{1–5} extending across primary and

specialist care settings, there is considerable international policy interest in increasing the proportion of the patient record that is captured in structured and/or coded format as opposed to the more traditional free-text representation of clinical data. However, finding an optimal balance between the more clinically intuitive free-text record and the more computable structured and/or coded record with respect to benefits and risks is far from straightforward.

The migration towards structured and/or coded representations within EHRs has so far tended to prioritise relatively formalised and consistent information structures such as (numeric) laboratory results, diagnoses, prescriptions, and a limited number of chronic disease monitoring datasets and disease/functional assessment scales. The extension of coding to a broader range of chronic conditions is hampered by challenges in agreeing consistent clinical information structures across clinical communities,^{6–7} and of populating EHRs with high-quality data.⁸ Other parts of the health record, such as presenting history, treatment goals and disease management advice given to patients are however still usually captured and stored as narrative (free-text) entries. For a patient's presenting history in particular, the potential benefit of structuring and/or coding this information to assist clinical decision-making, and the potential risk of a detrimental impact on a patient's personal story and perspective on health and illness have been debated in the literature over a long period.^{9–11}

The term 'patient history' may encompass a wide range of information about the past history of the patient that is volunteered during a clinical encounter—for example the

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clerking history taken during inpatient admission.¹² Within this broad interpretation there is a clinically important subset of the patient history that focuses on the presenting illness and current health status, which is the subject matter of this paper (see [box 1](#)).

There are several reasons for selecting this focused interpretation of patient history. There is wide variation in the extent to which this information is structured and/or coded, at present. Furthermore, there appears to be a reasonable body of opinions and arguments in favour of and against structuring and/or encoding this aspect of the clinical encounter,^{9–11} yet no clear consensus has yet surfaced to give weight to either one direction or the other. The considerable international momentum to establish national EHRs presents an important opportunity to inform policy makers and clinicians of the arguments for and against choosing one course of action over the other,^{13 14} and on priorities and best approaches to the development of clinical information structures and term lists.^{15 16}

Structuring is the process of organising information according to a logical model that is meaningful for humans (ie, rendering it possible to navigate and locate information easily) and/or computers (information is processable by computers). Coding is the translation of clinical terms and concepts into a computer interpretable format to support automated processing and reasoning. A well written patient history may be a narrative or structured document. A patient history captured

using a form or template will be structured, but not necessarily coded. Several arguments have been advanced in favour of increasing the structure and/or coding of the patient history. For example, it has been argued that structured records are more complete than unstructured records.¹⁷ It has also been argued that there are gains to be made in using automated processing of coded data for research and administration purposes,¹⁸ in decision support systems,¹⁹ or in quality of care monitoring for example.²⁰ Finally, data structures support the development of standardised interfaces, facilitating the use of medical record data by healthcare professionals and patients alike.²¹ These arguments support the significant, financial and organisational investments being made to realise these benefits.²²

In contrast, there are notable arguments against any increase in structuring and/or coding. These arguments stress the fact that applying codes or working within structures is effortful.²³ Furthermore, standards are not uniformly implemented²⁴; and there are aspects of the clinical encounter that structure and/or code-sets are not rich enough to capture.²⁵ It has also been argued that there are advances in technology that may soon make manual structuring and/or coding obsolete.^{26–28}

These arguments form the context of a review of structuring and/or coding of EHRs in general, but perhaps there are key components of the clinical record for which these arguments are more finely balanced, such as the presenting patient history. To inform appropriate strategy for the optimal representation of this information, it is essential to determine which of the arguments described here are supported by empirical evidence.

OBJECTIVES

To identify, appraise and summarise empirical evidence for benefits or risks of structuring and/or coding of the presenting patient history.

METHODS

Eligibility and search strategy

The criteria for inclusion during initial title and abstract screening were if the paper referred to any of the following:

- ▶ the process of obtaining information on the presenting problem from patients (eg, interviews, computer based or self-reporting);
- ▶ the quality of patient history information;
- ▶ the value of patient provided history information (eg, to aid diagnosis, assess status, monitor for deterioration);

Box 1 Key definitions

Coding

Coding is the translation of medical terms and concepts into a machine readable coded format that indexes them uniquely.

Narrative

Textual information expressed as phrases, sentences and paragraphs.

Presenting patient history

The information regarding the patient's present health situation and health status, volunteered by the patient or caregiver and elicited by direct questioning of the patient or the patient's caregiver, whether these are undertaken synchronously in a clinical encounter or asynchronously before or after a clinical encounter.

Structure

Arrangements of, and relations between, the parts or elements of something complex.

Structuring

Structuring is the process of organising information according to a logical model. This model is meaningful for humans or computers or both.

- ▶ re-use of patient history data (eg, to aid diagnosis, care planning for clinical audit, population health management, service planning, research, teaching).

The criteria for inclusion during full paper screening were if the paper met all of the following:

- ▶ the research included the electronic capture, documentation or use of the presenting patient history or equivalent information;
- ▶ the structure of the history was specified (narrative, organised under headings, fully structured, coded);
- ▶ a purpose for capturing or using the patient history was stated or could be inferred;
- ▶ some assessment was made of the benefits or risks of that approach to capturing patient history, or some benefit was derived from the presenting history.

Papers were excluded if:

- ▶ the setting for the study was not medical or social care;
- ▶ the structuring and/or coding activity pertained other parts of the health record (ie, a different interpretation of patient history, such as past medical history or drug history), or if the structuring and/or coding of patient history was not distinguished from other clinical information.

The protocol for this review (including the detailed search strategies) has previously been published.²⁹ The search strategy was developed by iteratively scoping the literature and through discussion with experts. To maximise sensitivity an extensive set of keywords and subject headings (MeSH) were used. Our search terms were based on four key topic areas: health records; history taking; code and/or structure; and benefits or risks, which were all combined using the 'AND' operator. The final search strategy for MEDLINE, as an example, is given in **box 2**.

Searches were conducted in MEDLINE, EMBASE, Google Scholar, CINAHL, IndMED, LILACS, NIHR, Paklit, PsycINFO. Hand searches of key specialist journals and the authors' personal libraries were also undertaken in parallel. This set of relevant papers was supplemented through snowballing and contact with authors and other experts. All papers meeting the search criteria were included regardless of the language of publication.

Titles and abstracts were screened independently by two authors (BF and DK) and full texts of potentially relevant papers were independently assessed for inclusion by the same two authors. Papers were included for

Box 2 Example search strategy for MEDLINE and numbers of hits returned

1) Benefits or risks: (4 591 987)

benefit* OR advantage* OR gain* OR assist* OR help* OR improve* OR ease OR easy OR desire* OR intend* OR risk OR cost OR barrier* OR upheaval* OR obstacle* OR obstruction* OR difficult* OR confus* OR disrupt* OR hazard* OR threat* OR problem* OR *danger* OR disadvantage* OR avoid* OR undesir* OR unwanted.

2) Code or structure (2 138 602)

code* OR encode* OR read code* OR diagnosis related group* OR international classification of diseases OR medical subject headings OR icd OR snomed OR hrg OR drg OR mesh OR language* OR ontolog* OR systematised nomenclature OR controlled vocab* OR structur* OR metadata OR template* OR form*

3) Health records: (95 075)

electronic record* OR health record* OR patient record* OR care record* OR medical record* OR ehr OR scr OR ecr.

4) History taking (4 451 621)

history taking OR clerking OR note capture OR note taking OR patient interview* OR reason for encounter OR clinical documentation OR structured documentation OR clinical noting OR Kardex OR interface terminology OR symptom* OR presenting complaint* OR concern* OR presentation* OR patient histor**

Final search

1 AND 2 AND 3 AND 4 (5511 results)

(benefit* OR advantage* OR gain* OR assist* OR help* OR improve* OR ease OR easy OR desire* OR intend* OR risk OR cost OR barrier* OR upheaval* OR obstacle* OR obstruction* OR difficult* OR confus* OR disrupt* OR hazard* OR threat* OR problem* OR *danger* OR disadvantage* OR avoid* OR undesir* OR unwanted) AND (code* OR encode* OR read cod* OR diagnosis related group* OR international classification of diseases OR medical subject headings OR icd OR snomed OR hrg OR drg OR mesh OR language* OR ontolog* OR systematised nomenclature OR controlled vocab* OR structur* OR metadata OR template* OR form*) AND (electronic record* OR health record* OR patient record* OR care record* OR medical record* OR ehr OR scr OR ecr) AND (history taking OR clerking OR note capture OR note taking OR patient interview* OR reason for encounter OR clinical documentation OR structured documentation OR clinical noting OR Kardex OR interface terminology OR symptom* OR presenting complaint* OR concern* OR presentation* OR patient histor**)

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full review if either or both screening authors judged that the inclusion criteria had been met.

A preliminary screening of filtered papers published prior to 1990 revealed that these were primarily focused on the technical feasibility of implementing and using computers to capture information from clinicians and patients, and the format of that information was largely dictated by the maturity of the technology at the time rather than clinical benefit. To verify this decision, two authors (BF and DK) reviewed 29 pre-1990 publications that had met the initial screening criteria and both agreed that these papers did not yield findings that were not better investigated in more recent publications. A decision was therefore taken (after publication of the original protocol) to exclude pre-1990 papers.

Selection of studies and data extraction

Data extraction forms were designed and piloted using an initial subset of papers. Data for all screened papers were extracted by BF and DK using the customised data extraction form with discrepancies resolved through discussion. Studies were appraised independently for quality by the two authors using the Newcastle-Ottawa Quality Assessment Scale (NOS) for cohort studies. This scale has three categories: selection (four questions); comparability (one question); and outcome (three questions) to score the quality of the study. A study was awarded a maximum of one star for each numbered item within the selection and outcome categories and a maximum of two stars was given for comparability. Thus a potential maximum total of nine stars were possible for each paper. Studies were not excluded based on methods or methodological quality, but the assessment influenced the importance given to the findings. Outcomes of interest were potential or actual benefits as a result of structuring or coding of patient history

information (eg, completeness, accuracy, time saving) and potential or actual risks (such as patient safety issues, structuring or coding errors, errors in decision making). Because of the nature of the topic and the heterogeneity of the studies and outcome measures used, quantitative summary estimates of effect were not calculated.

Data analysis

We developed a hypothesis framework to classify the different potential benefits and risks that might be identified from structuring and/or coding patient history ([table 1](#)), which was used to inform the interpretation of data.

This framework was based on our overall familiarity with the arguments in favour of and against formally organising this part of an EHR,^{30 31} supplemented by re-examining the literature on narratology in particular.^{10 11 32–35} Data were synthesised descriptively guided by this framework.

RESULTS

Initial searches resulted in 9207 papers for consideration, of which 10 papers were finally selected as satisfying our inclusion criteria (see [figure 1](#) for the PRISMA diagram).^{36–45} The key characteristics of these 10 studies together with a summary of their findings are presented in [table 2](#) and our quality assessment of these studies is summarised in [table 3](#). The 10 papers that met the inclusion criteria arose from a range of care settings, but were predominantly hospital based, with half of these emerging from research undertaken in emergency department settings. This does not necessarily reflect the distribution and use of structured history taking, but rather the nature of settings in which the value of structured histories has thus far been evaluated.

Table 1 Hypothesis framework for the benefits and risks from structuring and coding patient history

	Structuring patient history	Coding patient history
Benefits	▶ Prompts more complete history taking ▶ Allows patients to contribute to more complete histories ▶ Allows patients to contribute to more accurate and specific histories ▶ Make histories easier to use ▶ Improves patient satisfaction	▶ Leads to consistency which improves re-use ▶ Allows for automated processing, enabling a wider range of uses of the information ▶ Generates unambiguous data which improves accuracy in secondary uses
Risks	▶ Patient judgements about relevance are lost ▶ Fine details of history are lost due to the limits of the representation ▶ The limits of the representation make it difficult to use the data	▶ Complete but inaccurate patient history increases clinical risk

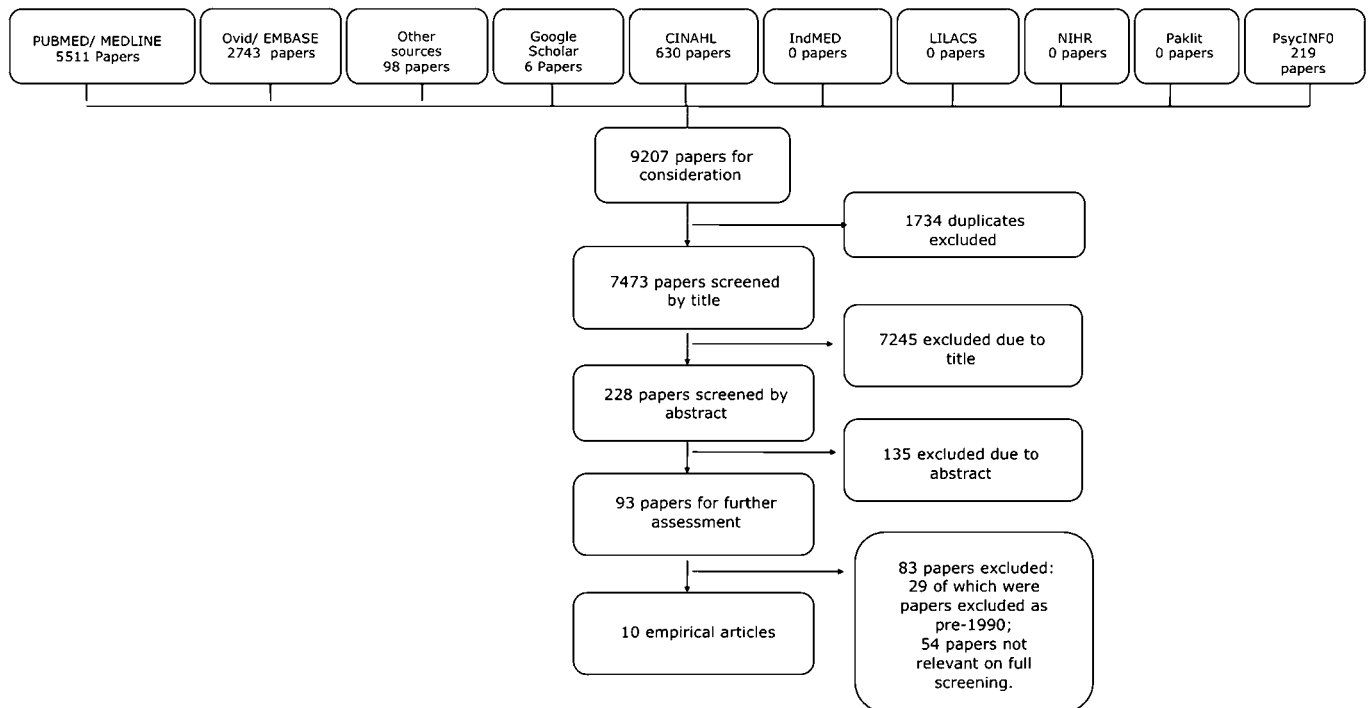


Figure 1 Flow (PRISMA) diagram, study identification and selection.

Empirically demonstrated benefits

The main demonstrated benefit of structuring the patient history was an increase in the completeness of information (table 2).^{39 40 42 44} However, it should be noted that completeness was usually judged in relation to the proportion of nominated data items that had values. Only three studies showed that the improvement in this completeness was relevant to clinical decision-making, such as improved diagnostic accuracy.^{40 41 43} In other words, a structured format increased the quantity of history data collected, but not necessarily its usefulness. This finding includes patient/parent provided information, which might be more detailed than equivalent clinically documented histories, but is not necessarily better used.³⁸

Although a potential value of patient/parent completed forms is the saving of clinician time there was very little evidence to support this.⁴⁴

One study used a structured history form for clinical research to investigate the most important (discriminating) presenting symptoms of acute myocardial infarction; that is, a structured history form was used to obtain the frequency of occurrence of possible presenting symptoms and features from a predefined set. This frequency distribution was compared with the eventual diagnosis to derive the positive predictive value of each symptom.³⁶

Structuring tools based on clinical guidelines, especially if they are dynamic and have branching questions, can produce complete and structured information that

can be coded. One study demonstrated that clinicians who used this information in contrast to unstructured history could sometimes make more accurate clinical decisions.⁴¹

Overall the evidence indicated that structuring patient history other than in the context of achieving completeness of information had not been the focus of recent research and as a result other potential benefits of structuring of patient history (table 1) had not been investigated.

Empirically demonstrated risks

None of the studies proposed looked for or reported a harm or risk situation through the use of a structured history (table 2). Certain risks, such as the non-acceptability to patients of completing a pre-consultation questionnaire, the inability of patients of diverse socio-economic and educational backgrounds and who are ill to use an on-screen form, the non-acceptability to clinicians of using a structured form and/or of reviewing a patient completed form, and data entry in a structured form being more time consuming, were raised by a few of the authors as a possibility,^{38 43 44} but were not encountered in practice.

DISCUSSION

Main findings

We found very little empirical evidence in support of structuring the history, no evidence of associated risks,

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Table 2 Key study characteristics

Author (year)	Setting	Population	Intervention	Outcomes
Body <i>et al</i> (2010) ³⁶	UK: ED	Patients presenting with suspected cardiac pain. 796 patients	A custom-designed CRF	Several 'atypical' symptoms usually render the diagnosis of AMI more likely, whereas many 'typical' symptoms that are often considered to identify high-risk populations have no diagnostic value In an urban general medicine clinic, a positive screen for bipolar disorder appears to be common, clinically significant, and under recognised
Das <i>et al</i> (2005) ³⁷	USA: a faculty and resident group practice of the Division of General Medicine	A systematic sample of 1157 patients between 18 and 70 who were seeking primary care at an urban general medicine clinic serving a low-income population	This study used the self-report instrument of the MDQ to screen bipolar disorder	
Porter <i>et al</i> (2010) ³⁸	USA: an urban children's hospital ED and a general community paediatric ED	1410 parents of children whose primary language is either English or Spanish	ParentLink (patent-centred technology) that captures clinically relevant and parent reported information Introduction of a clerking pro forma	ParentLink provided electronic information that met or exceeded the quality of data documented by ED nurses and physicians A stroke pro forma improves completeness of history taking
Davenport <i>et al</i> (1995) ³⁹	UK: Department of Medicine in a general hospital	244 prospectively identified consecutive patients with stroke before and after the introduction of the pro forma		
Day and Duggal (2003) ⁴⁰	UK: four dental hospitals	90 records of case histories of dental avulsions	Structured history taking sheet	A structured history should be taken for cases of avulsion as it was significantly better at collecting essential prognostic information Diagnostic accuracy of appendicitis was improved
Körner <i>et al</i> (1998) ⁴¹	Norway: emergency service	1764 consecutive patients	Structured preoperative data collection	Pro forma improved completeness of some data items. Potential value for clinical audit is proposed, but clinical benefit not assessed
Michele and Amegavie (2005) ⁴²	UK	A retrospective review of 100 case notes of children attending the paediatric outpatients department clinic as a revisit, irrespective of the age of the child or severity of disease Standardised patients	Paper-based paediatric asthma assessment pro forma, designed following a review of published evidence (literature and guidelines)	
Fung (2006) ⁴³	USA: an academic Veterans Affairs Medical Center		Computerised condition-specific templates	Templates prompt clinicians to collect appropriate history
Wallace <i>et al</i> (1994) ⁴⁴	UK: three A&E departments	1260 patients with head injury	Specially designed head injury pro forma	Details of head injury symptoms were completed in over 95% of all the patients seen

Continued

Table 2 Continued

Author (year)	Setting	Population	Intervention	Outcomes
Hedges <i>et al</i> (1998) ⁴⁵	USA: ED	126 patients presenting with chest pain	A two-part 'key' question (Key-Q)—'What are the symptoms that brought you here today?' and 'When did these symptoms start?' vs four questions	Measurement of out-of-hospital delay in patients with chest pain using a two-part 'key' question is possible

A&E, accident and emergency; AML, acute myocardial infarction; CRF, case report form; ED, emergency department; MDQ, Mood Disorder Questionnaire.

and no formal investigations of either benefits or risks from coding the history. Evidence for only some of the benefits of structuring shown in [table 1](#) was found, namely, structured templates can be used by clinicians and patients in care settings; they aid completeness of the record for items that were sought by the form; and the information captured can sometimes help improve diagnostic accuracy. However, even this evidence is not of a particularly high quality (see [table 3](#)).

Importantly, we were unable to identify any studies in which structuring the patient history was the primary subject of investigation. Rather, in the studies reviewed the structured history was a means of validating a new technical intervention such as a patient kiosk, or was a means of obtaining data to substantiate a clinical hypothesis or to validate a modification to a care pathway. The analysis of the record was either for its completeness or for the extent to which it provided the data that were needed for the research hypothesis. No investigation considered the accuracy of information collected, nor did any investigation look at the balance of use between structured and free-text portions of a form (although most offered both). A few studies investigated relevance by considering whether more complete information was simply more information or if the structure had encouraged the capture of important information that might otherwise have been missed. No investigation addressed behavioural dimensions of structure usage. Structured forms can act as a prompt not only to document more completely, but also to actually remind a clinician or patient to address a certain topic (ie, it can improve contemporaneous care, not just its documentation). This effect has been well established for reviews of chronic diseases,⁴⁶ but we were unable to identify similar investigations for patient history. None of the studies examined included a longitudinal dimension, for example using a previously structured history to compare the patient's current status with a past occasion.

Strengths and limitations

The contribution of this study has been to apply established systematic review methods to a complex socio-technical health informatics question in direct relation to the provision of clinical care. A further strength of this work is that a theoretical approach was taken to the analysis and interpretation of the results, directed by our conceptual framework ([table 1](#)). The main limitation of this review is that none of the studies examined the implications of structuring and/or coding patient history as the primary objective. There is a possibility that some studies may have been missed due to poor indexing in relation to this study perspective, although this is mitigated to some extent by our hand searching of key informatics journals in which publication of

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Table 3 Key findings

Author (year)	Key findings	NOS score for cohort studies (maximum score of 9)
Body <i>et al</i> (2010) ³⁶	Discriminating symptoms can be investigated by structured history taking	5
Das <i>et al</i> (2005) ³⁷	Structured symptom scoring instruments can be used for screening	2
Porter <i>et al</i> (2010) ³⁸	Structured data collection produces information of superior quality compared with unstructured documentation	6
Davenport <i>et al</i> (1995) ³⁹	Structured history taking leads to completeness of information	6
Day and Duggal (2003) ⁴⁰	History taking using structured paper instruments improves quality of records in terms of completeness of recording (against a predefined list of prognostic criteria). Structured instruments are significantly better at enabling junior members of staff to record key information	6
Körner <i>et al</i> (1998) ⁴¹	Significant improvement in diagnostic accuracy achieved using a structured registration form	7
Michele and Amegavie (2005) ⁴²	Pro forma improved completeness of some data items	6
Fung (2006) ⁴³	Templates prompt clinicians to collect appropriate history	—
Wallace <i>et al</i> (1994) ⁴⁴	Pro forma improved degree of completeness of recording of clinical details specific to head injury	6
Hedges <i>et al</i> (1998) ⁴⁵	Exact phrasing of a question during history taking can have an important impact on the accuracy of the response	2

NOS, Newcastle-Ottawa Quality Assessment.

approaches to structuring and/or coding patient history within EHRs were expected to appear. Another limitation was that all the studies reviewed were conducted in hospital or emergency department contexts; this is relevant since it is in primary care contexts that early presentations of illness typically occur and where there is therefore perhaps most to be gained from structuring and/or coding the patient history. One of the challenges in undertaking this work was that although structured proformas are often used in EHR systems, only a few of these studies were found to have focused on the presenting patient history and to have examined the value of structuring it. A number of studies were therefore excluded from this review because they included a few more general patient history items within a wider clinical encounter form, but had not examined the completeness, relevance, value or disadvantages of those history items per se. A large number of studies that had introduced an EHR system and evaluated its benefits holistically (eg, combining data entry, online historic record access, real-time access across an organisation, analysis and reporting features, decision support integration etc), but not distinguished the particular impact of structuring the patient history were thus also excluded. Structured forms were usually used as a means to obtain specific data for a study rather than as an objective in themselves to be evaluated, even within the 10 selected papers. The focus of the studies was therefore somewhat tangential to this research question, and at times the

impact of structured recording format needed to be inferred from the paper.

Considering the findings in relation to the wider literature

Recording patient history is challenging for several reasons. The patient's narrative has its own structure, the order in which information is divulged by the patient may alter the semantics of what is reported and there may be elements of uncertainty that should be recorded in the patient's narrative, which structuring and coding needs carefully to accommodate.⁴⁷ There may also be an impact on the interaction between the healthcare professional and the patient. Structures are usually predetermined and potentially apply to a large set of patients, whereas patient situations are unique and might require the documentation of information that was not anticipated when the structure was designed.⁴⁸

There is considerable interest in the prospect of natural language processing technologies being applied to clinical narrative, to obviate the need for structuring and/or coding by clinicians at the time of documentation.⁴⁹ The reliability, accuracy and safety of these techniques for patient level care decisions has not yet been established and it may be some years before the evidence of this alternative way of handling patient history becomes widely adopted. We therefore believe that any near term intent to gain computable value from patient history will need to utilise structures and/or codes.

Given the varying perspectives on the importance of the patient's history as the key to making an accurate

diagnosis, the increasing need for decision support to help clinicians cope with the overload of new medical evidence,⁵⁰ the importance of personalised healthcare⁵¹ and the need to engage patients more actively in the process of care,⁵² it is surprising that more research has not been undertaken to provide an evidence base for EHR adoption. We are also seeing a rise in expectations and emphasis on the use of structured and/or coded data for research.⁵³ The lack of empirical investigation into issues of completeness and accuracy surrounding this type of primary data collection should be considered by those planning to base their secondary analysis on these datasets.

CONCLUSIONS

There is a drive to structure and/or code all clinically relevant information in EHRs to benefit from computability of information. There are potential benefits and risks to patients of this approach. This review shows that there is no demonstrable evidence either for benefits or risks of structuring and/or coding of patient histories. While the studies reviewed here have shown that the use of structured formats can serve as a prompt for additional history details and result in greater consistency of information, there is a lack of evidence of benefit from either of these changes. We note that the absence of evidence does not equate with evidence of no benefit and suggest that research into this area of EHRs needs to be prioritised—investigating both benefits and risks—to provide a sound platform on which to consider whether or not to develop future policy in this area.

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Benefits and risks of structuring and/or coding the presenting patient history in the electronic health record: systematic review

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