Nursing constraint models for electronic health records: A vision for domain knowledge governance

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SUMMARY
Various forms of electronic health records (EHRs) are currently being introduced in several countries. Nurses are primary stakeholders and need to ensure that their information and knowledge needs are being met by such systems. International EHR standards have adopted the openEHR approach of two-level modelling. The first level is a stable information model determining structure, while the second level consists of constraint models or ‘archetypes’ that reflect the specifications or clinician rules for how clinical information needs to be represented to enable unambiguous data sharing. The current state of play in terms of international health informatics standards development activities is providing the nursing profession with a unique opportunity and challenge. Much work has been undertaken internationally in the area of nursing terminologies and evidence-based practice. This paper argues that to make the most of these emerging technologies and EHRs we must now concentrate on developing a process to identify, document, implement, manage and govern our nursing domain knowledge as well as contribute to the development of relevant international standards. It is argued that one comprehensive nursing terminology, such as the ICNP or SNOMED CT is simply too complex and too difficult to maintain. As the openEHR archetype approach does not rely heavily on big standardised terminologies, it offers more flexibility during standardisation of clinical concepts and it ensures open, future-proof electronic health records. We conclude that it is highly desirable for the nursing profession to adopt this openEHR approach as a means of documenting and governing the nursing profession’s domain knowledge. It is essential for the nursing profession to develop its domain knowledge constraint models (archetypes) collaboratively in an international context.

1. Introduction

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crucial in modern health care organisations to provide competitive advantage, support clinical decision-making, patient management, financial management, resource planning, resource allocation, priority-setting, strategic management and to change organisational processes. Health care organisations operate in a dynamic environment, and consequently, must be able to collect information or knowledge, such as evidence-based clinical or best practice guidelines as required, communicate internally and externally, apply new or existing knowledge and process information so that managers and clinicians can make decisions quickly and effectively. Typically, different systems have been designed to serve the different functions within a health care setting. The challenge is to design systems that can serve a range of functions and/or to integrate information systems such that semantic interoperability is achieved. System integration can be technologically difficult and tends to be costly [1], unless all systems comply with the same set of messaging/communication standards that:

- support medico-legal accountability and privacy;
- enable fast information retrieval;
- support unambiguous clinical information representation;
- ensure that the EHR contains meaningful and valid information;
- enable key patient information sharing between individual care providers;
- facilitate communication regarding request/instruction activation or completion in shared care environments;
- support the ability to extend the system to meet new information requirements without having to rebuild systems.

The openEHR approach of two-level modelling is able to meet these needs. The first level is a stable information model determining structure, while the second level consists of constraint models or 'archetypes' that reflect the specifications or clinician rules for how clinical information needs to be represented to enable unambiguous data sharing.

The overall aim of this paper is to explore to what extent nursing constraint models (archetypes), as defined by the openEHR foundation, can improve semantic system interoperability and enhance the benefits to be obtained by the introduction of EHRs. Within the context of the current state of play, we will:

- describe ontology-based knowledge domain constraints models (archetypes) and how these relate to EHRs;
- explore how terminologies may be used to describe the many nursing concepts that make up these models (archetypes);
- highlight advantages of standardising nursing archetypes and their link with the adoption of evidence-based practice;
- show why the nursing profession needs to adopt domain knowledge governance protocols.

2. Current state of play

Every day, new technologies become available claiming to offer solutions for a range of business problems. There are a number of technologies and initiatives that are being adopted by the health industry, such as improvements to supply chain management, evidence-based practice, use of the Internet to deliver health products, intranets and implementation of electronic health records. One of these new technologies is the freely available Archetype Editor downloadable from the openEHR webpages (http://www.openEHR.org).

Governments as well as individual health care enterprises and professional organisations have a responsibility to create an environment that is conducive to the take up of many and varied new applications of IT in the health industry.

In 2004, a European e-health action plan was published [2] to enable:

- better provision of information to patients on how to get treatment in other member states;
- coordinating the evaluation and assessment of new health technology;
- making the most of new IT and better integrating e-health policies and activities across Europe.

As a consequence, health care consumers in Europe are expected to have a far greater direct involvement in making decisions about their care and to use information technologies to interact with their providers. These changes are far-reaching and global; they are not just about technology, as they will affect everyone, everywhere.

Nurses constitute a major group of direct caregivers who between them need to determine what tests to conduct, therapies to prescribe, procedures to perform or to whom the patient should be referred for a second opinion or additional care. This is where the treating health care professional interacts with other direct and indirect care-givers. Such inter-
actions determine what information needs to be communicated to whom and when. Direct caregivers also need information about the quality and outcomes of the treatments they have delivered. Providing this type of information in formats that are readily accessible, timely and understandable is increasingly important in health care organisations. In Australia, a national framework for clinical information capture, storage, representation and use to underpin electronic health information interchange and to facilitate semantic interoperability of clinical information across the health system is under development [3].

2.1. Electronic health records (EHRs)

Electronic health records are considered to offer great benefits to patients and health providers, as current paper-based records have serious deficiencies. Australia is in the process of establishing HealthConnect a joint federal and State government initiative that aims to improve the flow of information across the Australian health sector via a secure network for online retrieval by consumers and authorised providers [4]. The expected benefits are detailed in Box 1.

Canada is another world leader with its electronic health record solution blueprint (EHRs blueprint) [5] that describes the business and technical architecture of EHR solutions to be implemented across Canada. This document will guide the development of EHR solutions, help jurisdictions develop their own technical roadmaps at lower costs and is freely available from the Infoway website [5].

Early 2004, President Bush announced that most Americans will have electronic health records within the next 10 years [6]. This was based on an earlier Institute of Medicine report [7] that had identified demonstration systems, indicating that electronic medical records, computerised ordering of prescriptions and other medical tests, clinical decision support tools and secure exchange of authorised information, improve quality, reduce medical errors and prevent deaths. His plan is being supported by significant funding and includes the adoption of health information standards, an increase in investment for demonstration projects as well as the provision of leadership via a subcabinet level position of a national health information technology coordinator to coordinate partnerships and guide health informatics standards development as well as via the many federally funded health services, such as veteran affairs. This proposed national health information network has been endorsed by thirteen major health and information technology organisations in an unprecedented joint collaboration [8].

2.1.1. What are EHRs?

There are many definitions as to what constitutes an electronic health record. The ISO Technical Report (ISO-TR20514) [9] defines a basic generic EHR as ‘a repository of information regarding the health status of a subject of care (patient or consumer), in computer processable form’. This document also identifies and describes sharable and non-shareable EHRs as well as integrated EHRs and EHR systems. It notes that:

“The difference between a non-shareable EHR and a shareable EHR is analogous to the difference between a stand-alone desktop PC and a networked PC, where the latter adds enormous benefits in terms of locating, retrieving and exchanging information using the internet, an intranet, email, workgroup collaboration tools, etc.”

This 2004 ISO Technical Report is the most authoritative document to describe the EHR as it has been developed through international consensus. Box 2 contains this report’s definition of shareable EHRs taking place at three different levels where the third level is referred to as an ‘integrated care EHR’. This is defined [10] as:

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**Box 1: HealthConnect’s expected benefits realisation:**

- rapid access to vital and accurate health information;
- reduced duplication of services;
- more time available for direct care;
- greater portability of health records for an increasingly mobile population;
- more control for consumers over who can access their health information;
- more active participation by consumers in decisions about their health care;
- better quality information exchange between health care providers for improved diagnoses and better quality care;
- a more comprehensive picture of Australians’ health to promote advances in the diagnosis and treatment of illnesses and better targeted decisions about health care.

ISO technical specification detailing these has technical requirements been agreed upon. Another 2004 it is essential that a detailed set of user and tech-
prospective''.
information which is retrospective, concurrent and quality integrated health care, and it contains
mary purpose is the support of continuing, efficient model which is independent of EHR systems. Its pri-
dardised or commonly agreed logical information
forms, stored and transmitted securely and acces-
status of a subject of care in computer processable ''A repository of information regarding the health
level 3 sharing is achieved and the object of the EHR is to support the integrated care of patients across and between health enterprises, it is called an Integrated Care EHR (ICEHR).
Health Informatics, Electronic Health Record, Definition, scope, and context Clause 4.3.

Box 2: Shareable EHR definition
The sharing of EHR information can take place at three different levels:
Level 1: between different clinical disciplines or other users, all of whom may be using the same application, requiring different or organisation of EHRs;
Level 2: between different applications at a single EHR node, i.e. at a particular location where the EHR is stored and maintained;
Level 3: across different EHR nodes, i.e. across different EHR locations and/or different EHR systems.
The shareable EHR used for Levels 1 and 2 will contain mainly detailed information required for patient care within a single loca-
tion, and it will be created and maintained on a local EHR system as described in Clause 7.3. However, it will also usually contain at least some health summary information such as a problem list, allergies, past medical history, family history, current medications, etc.
When level 3 sharing is achieved and the object of the EHR is to support the integrated care of patients across and between health enterprises, it is called an Integrated Care EHR (ICEHR).
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"A repository of information regarding the health status of a subject of care in computer processable form, stored and transmitted securely and accessible by multiple authorised users. It has a standardised or commonly agreed logical information model which is independent of EHR systems. Its primary purpose is the support of continuing, efficient and quality integrated health care, and it contains information which is retrospective, concurrent and prospective".

For an EHR to realise any of the above benefits, it is essential that a detailed set of user and technical requirements be agreed upon. Another 2004 ISO technical specification detailing these has recently been adopted. In addition, there needs to be national agreement on an EHR architecture and a model of the generic features of an EHR. Agreement on these issues is necessary to enable the desired usage and the sharing and exchanging of electronic health records. This needs to be independent of the technology used to implement the EHR system. The EHR architecture should also be unconstrained by current organisational structures, as all health care organisations need to adopt the same standards for a true EHR to exist.

The requirements for a truly global EHR should ensure that it can be used, shared and exchanged between clinicians of all disciplines, across all sectors of health, different countries and different models of health care delivery. It should also support secondary uses, such as research, epidemiology, population health, health administration, financing and health service planning. Finally, the EHR should facilitate the evolution of existing systems as well as the construction of new systems.

Much standards development work is continuing internationally with considerable Australian input to enable effective electronic communica-
tion as required for widespread EHRs adoption. In particular, the European standard, EN-ISO 13606-1 Electronic Health Record Communication, originally a four-part standard is now being enhanced to become a five-part standard by adopting the openEHR two-level modelling approach [12]—part 1: reference model is almost ready for an interna-
tional ballot; part 2: archetype model is expected to be available some time during 2005. This is arguably the single most important standard requiring international consensus, as it defines the fundamental EHR infrastructure requirements.

The adoption of 'archetypes' or knowledge domain-based constraint models is essential, as this facilitates EHRs to accommodate changing medical and health service delivery practices over time. This represents an innovation in knowledge engineering as it facilitates knowledge domain experts (clinicians) to electronically document content models, such as blood pressure, an ECG result or discharge summary, describe clinical workflow processes, such as a patient’s assessment, incorporate clinical or best practice guidelines or a knowledge domain ontology. This is achieved by separating knowledge domains from runtime information and design time models that collectively make up an information system. Archetypes are the building blocks of the health knowledge environment. Adop-
tion of the EN-ISO 13606-1 standard ensures the sys-
tem is able to manage this. The openEHR approach [13] focuses on the semantic interoperability of complete EHRs or EHR extracts and is the basis for the new European standard. Current clinical information systems directly incorporate clinical knowledge concepts within the software and databases making these systems very costly to maintain, as changing knowledge will eventually make such sys-
tems obsolete. Whereas through the adoption of
archetypes, all clinical and other domain specific knowledge, that frequently changes, now resides outside the software in archetypes that can be expressed and shared using the archetype definition language (ADL). Their link to a particular data model, such as the one defined by EN-ISO 13606, provides the basis for querying information. The development of gateways will make it possible to access and use information from legacy systems [14].

2.1.2. The openEHR approach

The aim of openEHR is to enable the development of open specifications and software for EHR systems. It is based on the results of the European Union’s GEHR-Project. GEHR is an acronym for Good European Health Record, respectively, Good Electronic Health Record. Following GEHR, several projects extended and refined its results (e.g. the synapses and SynEx projects). All these projects influenced the openEHR architecture and the pioneering of a two-level modelling approach for EHRs [13]. An overview of this approach is given in Fig. 1.

The first level is the reference information model, which is pared down to the minimum to support the medico-legal requirements and record management functions. This ensures that clinicians can always send information to another provider and receive information, which they can read—thus ensuring data interoperability. The second level involves the openEHR archetype methodology—a way of sharing evolving clinical information, so that it can be processed by the receiving provider—thus ensuring semantic interoperability.

A blood pressure archetype, for example, represents a description of all the information a clinician might want or has to report about a blood pressure measurement. Basically, one archetype models or represents one clinical or other domain specific concept. They are specifications for groups of data that are discreet, highly related and clinically meaningful. Archetypes define the business rules (constraints) for valid values and they use terminology to identify components within the archetype. They are necessary for value-added EHR applications, such as intelligent decision support and care planning and are technology independent.

Through the use of freely available archetype tools, e.g., the Archetype Editor, clinical groups are empowered to control the way that EHRs are built up, using designed structures to express the required clinical data and assuring that all necessary constraints on the values of record components are observed. This ensures that all data in an EHR system are valid at two levels, due to data conformance with an information model and the knowledge domain via agreed concept definitions. Design principles of openEHR are described in more detail in [15], but the key innovation of the openEHR architecture is that it separates record keeping concerns from clinical data collection using archetypes [16] and thus enabling patient-centred, longitudinal, comprehensive and prospective EHRs. Experiences in two field trials supported by the Australian General Practice Computing Group (GPCG) showed that the approach does work [17] and it is now the basis of a major trial of data sharing between hospitals and primary care in Australia.

Fig. 1 Overview of the openEHR two-level modelling approach for EHRs [3]. The information stored in the EHR is an instance of the underlying information model. The information in the EHR is constrained by archetypes (and templates), which are instances of a knowledge description language (e.g. archetype definition language).
within the framework of HealthConnect, the Australian initiative for a national health information network and used in further projects [3,16]. First results are promising.

2.1.3. Achieving semantic interoperability
Greater standardisation of health information and knowledge needs to be achieved if we are to make better use of the data and knowledge collected by health care organisations. In health informatics, the adoption of a standard way to represent both the meaning of information (a ‘normative’ reference or terminology) and the known place or context enable clinicians to share information in a form that computers can understand. Many terminologies have been developed to suit a variety of purposes. Their effectiveness relates to a balance between the number of terms (size) and the specificity or level of detail. No matter how many terms and categories are offered some concepts will rightly belong to more than one category. As a consequence, provision is made for either cross-referencing or by adopting more than one hierarchy for some single concepts within a terminology so that data can be retrieved consistently. Mapping based on complex rules between the terminology and the reporting classification is a critical step in achieving consistent reporting.

Coding and classification systems help to standardise the collection of health information to suit specific purposes, such as resource allocation. They aim to define specific concepts within confined contexts. Understanding context is critical to the communication of meaning or semantic value. "Any meaningful exchange of utterances depends on the prior existence of an agreed set of semantic and syntactic rules" [18].

Data types are technical specifications of the way different types of data are entered and handled in information systems. Data types are fundamental building blocks of computer software, electronic messaging and the EHR. A small team of experts are now engaged in identifying Australian requirements for health data types. There is a realistic expectation that the Australian health data types, being largely an amalgam of the HL7 and CEN TC251 data types with modifications to overcome implementation difficulties, will have a significant influence on the emerging ISO standard for health data types (MacIsaac et al. 2004, unpublished working paper for HL7 Australia).

Current clinical information systems tend not to have adopted standard data models or data types, indeed these tend to be vendor specific, thus data sharing between many systems is difficult if not impossible to implement. One way of overcoming this difficulty is via the adoption of standard structured messages. This is most successful between two systems but very complicated when multiple systems need to be connected. It works when there are limited and pre-determined communication requirements. HL7, an international health information standards development organisation, has identified over 400 different coding systems currently associated with its messaging standards. A major infrastructure project on data definitions and standards is being managed by the Canadian Institute for Health Information (CIHI). Canada has invested in 17 major projects since 2002 towards achieving system interoperability, including provider and client registries, an enterprise master person index, a national electronic claims standard, drug information and diagnostic imaging systems [19].

Data dictionaries are one tool used to promote the standardisation of data. The Australian Health Ministers’ Advisory Council has endorsed the National Health Data Dictionary (NHDD) as the repository of data standards, including clinical data specifications to support electronic health records development in Australia. The NHDD standardises the meaning and representation of data used in the communication and analysis of health information by stakeholder consensus. This, as well as many national minimum data sets, are managed by the Australian Institute of Health and Welfare (AIHW) who are re-engineering existing metadata content to develop the Metadata Online Registry (METeOR) [20]. A business case for a National Clinical Terminology is under development as part of a 2005 national work program managed by the Australian National e-Health Transition Authority (NeHTA) [21].

2.1.4. What is the relationship between terminologies and archetypes?
Archetypes are agreed models of clinical or other domain specific concepts and need to adopt a standard set of terms for each archetype. These terms can come from any number of terminologies. Archetypes specify groups of data that are discreet, highly related and clinically meaningful. They define the business rules (constraints) for valid values and they use terminology to identify components within an archetype. They enable information to be specified in a far more complex form than is possible in message structures, they can evolve over time yet remain standardised. In addition, there is no need to only use one terminology as the term that best describes the relevant concept is adopted within the archetype by formally expressing the combination (context) of data. It
is also possible where appropriate to define small unstructured term sets within the archetype itself. This enables the addition of, for example, ‘patient position’, such as sitting, standing, etc. to a blood pressure measurement.

Archetypes are formal information specifications written in ADL allowing clinicians (information users) to author archetypes so that these specifications can become agreed standards. Archetypes 'model' domain knowledge and enable machine level semantic interoperability as they describe rich information structures by indicating:

- how the information is to be expressed;
- what is optional and what is mandatory;
- what is a sensible value for each data element;
- any other rules that need to be expressed.

Another advantage of using archetypes is that computers can, at the time of data entry, validate data and alert the user to any error as archetypes control data quality through their rules. Sharing of information requires the adoption of standard terminology and data structures. Archetypes offer a generic approach to structuring health information for all uses where information is shared.

2.2. Ontological domain knowledge and archetypes

Every health professional has command of a body of knowledge that needs constant updating. Professional organisational intellect is said to operate at four levels that increase in value. This intellect relates to: cognitive knowledge (know-what), advanced skills (know-how), systems understanding (know-why) and self-motivated creativity (care-why), where the last level is needed for people to adopt change [22]. Knowledge represents intellectual assets that are of primary importance in the safe provision of quality health care. The dimensions of knowledge generation and its management have huge implications for the health industry. Knowledge management requires the adoption of a set of processes that enable the creation, capture, organisation, sharing, dissemination and use of knowledge, including the use of data mining tools.

It is argued by some [23,24] that the adoption of an ontological framework facilitates the building of better and more interoperable information systems. An archetype ontology built on a domain-based concept model, needs to be identified to enable the mapping of individual archetypes to a generic knowledge framework. This enables their use alongside other knowledge resources sharing the same domain concepts. Such an ontology facilitates unambiguous communication of complex and detailed concepts. A domain ontology catalogues various aspects known to exist within the domain of interest from a specific point of view to suit a defined purpose. An ontological domain knowledge model shows how key concepts relate to one another and is usually based on a philosophical or theoretical foundation. Such knowledge domains form the basis of rules for decision support in clinical practice as well as for all other areas of decision-making. The term ‘ontology’ in the field of health concept representation describes the representation of concepts and the reality they attempt to describe (Fig. 2). For example, terminologies, classifications, knowledge bases, nomenclatures, etc. are all examples of attempts to represent an ontology [25]. Beale [26] has identified five ontological levels, foundational (data types), data sharing where minimal ontological commitment enables data exchange, invariant domain concepts, such as ‘observation’ or ‘protocol’, representing the base ontological commitments of a domain, variant reusable atomic domain concepts, such as ‘apgar score’, ‘blood pressure measurement’ and variant local context specific concepts, such as ‘asthma note’ or ‘ante-natal exam’.

Ideally, an ontological approach is used to write up archetypes such that they accurately reflect domain knowledge. Such knowledge needs to be based on evidence or best practice although it can include ‘tacit’ knowledge acquired by experts and agreed to by consensus. A good example of this is the work undertaken in the European-based Wise-care Project [27], which we have used to demonstrate how such expert knowledge can be used to develop archetypes.
2.2.1. Information specifications for archetype development

One main idea of the archetype approach is to empower domain experts (nurses) to create and change the knowledge inherent in archetypes. The openEHR Archetype Editor was built as a tool to support the domain experts' development of archetypes by providing them with an easy-to-use graphical user interface making the abstract openEHR archetype model tangible. While the Editor is quite intuitive, domain experts should have a basic understanding of archetypes and openEHR's logical building blocks of an EHR (folders, compositions, sections, entries, clusters, elements and data values) to build useful archetypes. Basically, an archetype defines:

- a whole, distinct, domain-level concept;
- constraints on instances of the openEHR information model, which express a valid structure (i.e. composition, cardinality);
- constraints on instances of a reference model, which express valid types and values.

An archetype can be a specialisation of another more general archetype. An EHR entry, which has been archetyped will have the same meaning no matter where it appears in the EHR. While archetypes can be developed for various EHR building blocks, the most common archetypes probably are those for EHR entries. Entries are specialised into observations (e.g. the patient's blood pressure), evaluations (e.g. the diagnosis) and instructions (e.g. a medication order).

Commonly, archetypes have state and protocol data; state data are required for safe interpretation of the archetype's concept (e.g. patient is sitting or standing when measuring blood pressure). Protocol data are not required for safe interpretation of the concept (e.g. the device used to measure weight and its last calibration date), but may be valuable, e.g. for quality assurance purposes. While state data must be displayed, protocol data are usually not displayed to the clinician, but available in case it is needed.

Fig. 3 shows an example of how a nursing archetype can be modelled using the Archetype Editor. Fig. 4 shows an extract from the actual ADL-representation of the corresponding archetype. The design of this Editor guides the user to adopt an ontological approach to model each domain concept. If we have consensus amongst all nursing specialties than this shows the general oral assessment relevant for all nursing specialties, then the general oral assessment could be modified to suit various nursing specialties, by, for example, adding further elements. It might be relevant for oncology nurses to document if the saliva is watery, thick or ropy or absent [27]. It is sometimes more intuitive for clinicians not to specialise archetypes. An alternative is for the saliva-element to be included in the general archetype, but made optional. Completed archetypes can then be grouped together using openEHR templates. A template could be equivalent with a computer screen form, for example. Templates can also further restrict archetypes, that is, make the saliva-element mandatory for use in a special oncology clinic. As an archetype has the same meaning no matter where it appears in the EHR, there is no need to standardise templates.

2.3. Evidence-based practice and archetypes

Evidence-based clinical practice is playing an increasingly important role as health services demand high quality and cost effective health care delivery. Nurses are significant practicing clinical stakeholders. Consequently, it is imperative that nurses along with all other health professionals, identify what data sets are required to reflect evidence of their practices. Definition of minimum data sets for treatment practices, diseases and procedures allow the reporting of key indicators to support outcome research and the evaluation of health and nursing services. Widespread adoption of standard nursing archetypes will improve our ability to undertake practice evaluation from which best practice guidelines can be developed. Indeed, it will ultimately be possible to undertake 'virtual' or randomised clinical trials (RCTs) using existing databases, real world demographics, including severity of illness, from which homogeneous patient cohorts are selected to enable evaluation of nursing care outcomes. Once standard archetypes are widely used, it will be possible to access large databases and manage the many confounding variables and reliably evaluate nursing practice in the real world. This effectiveness research, also known as clinical practice improvement (CPI) [28], is, especially, beneficial for the nursing profession as the results facilitate the improvement of routine nursing care and it is far less costly to use as it accesses operational data.

Evidence-based clinical practice requires the identification of data or information that represent or reflect what is occurring. Current informatics building blocks for evidence-based practice include [29]:

- standardised terminologies, such as the ICD-10-AM, SNOMED CT, ICNP and many others;
Fig. 3 Example for modelling a nursing archetype using the openEHR Archetype Editor. This archetype models a general oral assessment (modified from the Oral Assessment Guide of the Wisecare Project).

- digital sources of evidence, for example, automated care plans documenting actual care provided;
- technical, messaging and terminology standards that facilitate health care data exchange between information systems;
- informatics processes that support the acquisition and application of evidence to a specific clinical situation;
- informatics competencies by care providers enabling the best possible data collection, retrieval and use of data from information systems;
- adoption of appropriate computing and telecommunication technologies.

Archetypes incorporate most of these, so that in the future, we only need to concentrate on identifying which archetypes need to be standardised to enable practice evaluation and the generation of new knowledge.

To enable the collection of evidence of best practice, it is also essential that we use unique patient identification, unique provider identification and resolve issues of ownership and access/custodianship of electronic health records. Standard data and data structures are required on a per episode, per provider or per patient (case basis) over any time period incorporating practice data provided by a number of providers and organisations. Such every day practice data can then be compared and evaluated in terms of patient outcomes from which best practice guidelines based on evidence can be established. It is important that nurses and all other clinicians are equipped with the skills to interpret this information and that health care organisations invest in information systems that can synthesise and present this information in
meaningful ways. Health service managers need to create an environment that facilitates innovation and problem-solving and thus stimulates the generation of new knowledge.

3. Nursing constraint models (archetypes)

Nurses as a profession need to take charge of managing their domain knowledge. We need to develop a framework for managing archetypes and for identifying which need to be standardised, which are nursing domain specific. Nurses need to work in multidisciplinary teams to ensure that those archetypes that meet many clinical user needs adequately meet nursing information needs. We need to minimise redundancy.

We suggest that the current full draft international ISO standard-integration of a reference terminology model [30] for nursing be used as the basis for such a framework as this provides the conceptual structures as represented in a reference terminology model. This standard consists of reference terminology models for nursing diagnosis and nursing actions and reflects attempts at harmonisation with evolving terminology and information model standards outside the domain of nursing. It may be that we should concentrate on developing sets of archetypes to accommodate these two key areas of nursing practice. However, it may be that an archetype for an oral assessment, for example, is equally applicable to knowledge domains other than nursing? The development of a structural framework for archetype development and management is expected to require the adoption of principles not unlike those used for the development of a classification system or terminology. This is an area for further exploration.

We argue in accordance with Rector [31] that a comprehensive nursing terminology might simply be too complex and too difficult to maintain. As the openEHR archetype approach does not rely on big standardised terminologies but on micro-
required to effectively adopt EHRs. To facilitate the generation of new knowledge through research based on routine clinical data and thus overcome the shortcomings of terminology-focused approaches, the degree of semantic system interoperability is highly dependent on the quality of the terminology used. Our experiences confirm that the terminology harmonisation, maintenance and general governance are key factors for success in this area. The greater flexibility during standardisation processes offered by the openEHR archetyping is of great value here. Furthermore, Garde et al. [33] concluded that openEHR can support multi-centre research based on routine clinical data and thus facilitate the generation of new knowledge through continuous practice evaluation.

It is highly recommended for knowledge alliances or clinical partnerships to be established for the purpose of developing evidence-based nursing archetypes. These may also be referred to as ‘practice communities’ [34]. One good example is again the process adopted in the European Wise- care Project where nurse experts agreed on data definitions, data collection and usage to improve nursing care and patient outcomes [27]. Knowledge represents intellectual assets that are of primary importance in the safe provision of quality health care. The dimensions of knowledge generation and its management have huge implications for the health industry. Knowledge management requires the adoption of a set of processes that enable the creation, capture, organisation, sharing, dissemination and use of knowledge. Many of these ‘knowledge artifacts or repositories’, such as archetypes need to be standardised, managed and maintained by the relevant domain knowledge experts. Collectively, this will create the knowledge environment required to effectively adopt EHRs.

3.1. Domain knowledge governance

Once we have professional consensus regarding best practice based on evidence expressed in the form of archetypes, we need to consider how to manage, maintain, update and disseminate these. We already have organisations, such as the Cochrane collaboration, an international not-for-profit organisation, providing up-to-date information about the effects of health care. They also have a Cochrane library containing regularly updated evidence-based healthcare databases [35]. It is highly desirable to either use an existing or establish a new organisation of this kind to manage generic standard archetypes and to make these available. However, there will be a number of archetypes that will reflect specific clinical knowledge domains that can only be managed by the profession that specialises in that area of practice. In medicine, the professional colleges are in charge of their specific knowledge domains.

The Australian National Nursing Organisations Group, now consisting of more than 50 organisations, was established in the early 1990s. They meet twice annually to discuss national issues. One of these was the designation of nursing specialties and credentialing of specialty practice. In 1995, agreement was reached that there should be three categories of registered nurse defined in Australia: the beginning RN, the expert/advanced RN and the expert RN. The development of generic competency standards was undertaken. These were later adopted and used by specialty nursing groups who developed their specific competency standards [36]. These are now used as the basis for credentialing individual nurses for each specialty. Thus, each organisation governs their special knowledge domain as expressed by means of competencies.

This type of work could also be adopted as the means of differentiating between generic and specialised nursing archetypes either nationally or internationally. In addition, there is a need to have a national and/or international entity that is authorised to work with knowledge domain experts to develop and manage standard archetypes. We need a formalised process to ensure that standard archetypes are evidence-based, reflect current best practice, use the most appropriate terminologies, are updated as required, are easily disseminated and made available to all who need them in a timely manner and to ensure that redundancy is minimised. Organisations, such as the Australian Institute for Health and Welfare or the Canadian Institute for Health Information may well be in the best position to do so, but it would require a change to their existing organisational mission and operations. Such organisations are best placed to take care of generic archetypes but this still leaves a gap of how to best manage specialised archetypes. The issue is about who takes responsibility for the domain knowledge content? We argue that the knowledge domain experts need to take on this governance role. However, the issue of scope and boundaries of practice will not be easy to resolve.

4. Conclusion

We need to take note of changes currently taking place, consider the long term implications, activate a paradigm shift in thinking and be pro-active to make the most of the opportunities and challenges confronting us today. It is clear that internation-
ally there is strong desire to develop and implement health information systems that have semantic interoperability. There is a global trend towards the implementation of EHRs along with the desire to make the best possible use of available technologies to improve patient safety and outcomes and contain costs. We have presented the current state of play regarding the most authoritative understanding of EHRs. We have shown how the adoption of the openEHR approach optimises the ability to achieve these overall objectives. Not only does this require standards developers to work more closely with domain knowledge experts, but it also requires a paradigm shift regarding the methods adopted. We need to develop a framework or classification system for archetypes. We need to establish who governs which knowledge domain. We need a process for engaging knowledge domain experts, for identifying what archetypes, we need and to assist with development. We need to identify individual ontological knowledge domains and assess priorities for archetype development. We should no longer be concentrating on getting one standard nursing terminology but we should divert our efforts toward concentrating on getting one standard nursing terminology and adopt, as well as the adoption of evidence-based practice principles will then become part of that effort. Nurses are well placed to lead this, as we have strong international professional liaisons.

References

[19] Canadian Institute for Health Information (CIHI), http://secure.cihi.ca/chweb/home_e.html, accessed 13.06.05.


