

# Electronic Health Records, Semantic Interoperability and Politics

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## Abstract

*An opinion paper exploring links between sustainable health systems, electronic health records, semantic interoperability, standards and national e-health strategies. It provides a rationale for why there needs to be a paradigm shift in thinking and explains the need for adopting a set of technical standards and establishing a supporting national infrastructure. It is argued that only then can Governments expect to be able to successfully implement health reform to meet their future vision and achieve a sustainable health system.*

**Keywords: Electronic Health Records, Standards, Interoperability, Politics, Computer Models, Terminology**

## 1. Introduction

It is widely acknowledged that the health industry represents a large slice of any nation's gross domestic product. The Organisation for Economic Co-operation and Development (OECD) median health to GDP ratio for 1995, 2000 and 2005 was respectively 7.5%, 8.1% and 9.0% [1]. The health to GDP ratios for some countries in 2005 demonstrate this vividly and are presented in Table 1. In common with most developed nations, Australia's health system is struggling to control costs as is evident by increasing health to GDP ratios.

Country§	2005§
United Kingdom§	8.3%§
Australia§	8.80%§
Italy§	8.9%§
New Zealand§	9.0%§
United States of America§	15.3%§

**Table 1:** Health to GDP ratios in 2005

Our health industry is knowledge intensive and constantly changing as a result of ongoing health care research, technology developments and service delivery innovations. Its core business relies heavily on clinical data collected from patients and multiple health care providers, stored in a variety of systems and locations. Such information then needs to be electronically transferable to be stored in consolidated individual electronic health or medical records. This information then needs to be made available in a safe computable format. That is patient safety cannot be compromised by software that processes clinical data inaccurately. Information collected and stored in electronic health records needs to be structured in a manner that enables various software applications and authorised users to extract and make further use of relevant information easily. Data may need to be collected from many

and varied information systems to be stored in one individual record. Collectively such data are processed to provide new information which in turn is applied with existing knowledge to support clinical decision making concerning one patient.

Information extracted from multiple individual records is used to support multiple functions including decision support, managed care, resource management, research, practice evaluation, public health, reporting for national statistical data collections, health policy analysis and more. It isn't just about moving transactions electronically! It's about being able to process, aggregate and compare information received. It is about linking and extracting information pertaining to various aspects of health service delivery as recorded in individual patient records via various data extraction, including data mining, and data aggregation processes to create new information and knowledge. Successful and meaningful data linkage is also dependent upon the

adoption of standard terms and syntax. It is about making use of information from individual records to support clinical, management, public health, policy and other decision making that ultimately dictates patient safety, the quality of care provided, the costs incurred and overall health system sustainability. Better-informed decisions usually result in better clinical outcomes and reduced costs. Sustainable health system characteristics.

### 1.1. Sustainable health system characteristics

Every nation's government would like to have a health system that provides access to all necessary health services for its population, irrespective of location or the individual's financial status. On the demand side we know that many people's lifestyles contribute to high incidences of ill health. We are also experiencing the need to manage more people with chronic diseases in conjunction with a larger ageing population in the developed world such that they need a variety of health services from many different health care providers over long periods of time. On the supply side we are experiencing an ageing health professional community, many are due to retire in the next 10 or so years and our workforce planning efforts have left us wanting. For example Australia's health workforce is ageing more quickly than the non-health workforce. The proportion of its health workforce aged 55 years and over rose from 11% in 2001 to 14% in 2005 [2]. The introduction of eHealth strategies is seen as a significant means of reconciling these differences. That is, by making optimum use of available technologies we are able to make better use of available human resources irrespective of their location.

Such effective use of health professional expertise is only possible with the national adoption of semantic interoperability between health information systems so that clinical information can be shared and made use of

by specialists providing a consulting service from a distance. Increasing healthcare demands within a resource constrained environment challenge effective continuity of care especially for more mobile populations. A basic requirement of such strategies is that we develop some electronic means for storing patient data. The electronic health record thus becomes a basic plank in our sustainability infrastructure, because many of the crucial data feeds needed to monitor health system behaviour come from the record, wherever it is held, or however it might be structured. With the merging of electronic health records and decision support systems, clinicians are increasingly in a position to make decisions based both upon the best scientific evidence, as well as patient-specific data. Sustainability arises out of good system design.

For this to happen, experience repeatedly shows that health information systems need to be designed and used in a manner that integrates them with daily workflows within any organization to achieve operational effectiveness at all levels. Many now argue that optimum efficiencies can only be achieved with the widespread adoption of *semantically* interoperable information systems i.e. systems capable of transferring, sharing, exchanging and meaningfully using information for decision support, regulatory reporting, population surveillance, clinical practice evaluation, outcome analysis and more. In other words, interoperability should enable the reuse (and avoid the 'waste') of data for multiple, often very different purposes [3]. One recent study of information sharing and integration in the public sector supports this view [4], identifying that the primary integration problems are semantic issues: relationships between information and decision rules, data quality, inter-organisational interactions, collaboration and trust. Finally, it is important to recognise that information technology is not a universal panacea, and poor design and use of IT can itself lead to unsustainable practices and system behaviours. IT is only one

component of any clinical service, and not the end goal itself, a maxim forgotten enough to be restated *ad nauseam*. Sustainable services require significant emphasis on change management and organisational process, as recent explorations into sustainable public health services is demonstrating [5,6]. These requirements plus a focus on reducing the demand for health care including the adoption of patient centred self management need to be viewed as the drivers for a sustainable health system.

To meet these health system sustainability requirements a nation needs to invest in the establishment of a fully networked health economy. Many nations have made a start in recognition of the potential benefits to be realised from ehealth by initiating ehealth implementation strategies.

### 1.2. Aim of this paper

The primary focus of this paper is on the introduction of electronic lifelong health records for every individual as this is the foundational building block for any national ehealth strategy. It questions what a well-constructed system for adopting and accessing health records electronically should look like and identifies what the key IT characteristics that make the desired degree or level of interoperability between health care (knowledge-based) distributed systems possible?

### 1.3. Political relationship

Success is viewed as being largely dependent upon national leadership, funds allocated and political decisions made. Such decisions are based on the many and varied relationships between stakeholders, their power and influence. Thus there is a tendency for such decisions to be based on self interest hidden by spin, rather than on a strong or passionate desire to achieve a specific goal to benefit the population at large requiring a paradigm shift in thinking based on available evidence. In the absence of national requirements regarding system compliance with specific stand-

ards we have witnessed large software corporations to be very good at selling their products despite these systems not meeting the optimum clinical business needs and information flows of healthcare providers [7]. Ideally decisions are made based on such evidence and/or a sound understanding of all the issues rather than primarily on concerns regarding a major stakeholder group with financial interests such as existing large IT vendors. Furthermore ‘universal implementation of proprietary Electronic Health Record (EHR) systems has the potential to wrest control of the doctor-patient relationship from doctors and their patients’ [8]. Late 2008 staff at the National Health Service (NHS) in the United Kingdom (UK) responded to an ‘*increasing need to treat information flows holistically throughout the NHS, from one care encounter to another, through to public health and strategic planning services. Breaks in the information flow, unavailable information (e.g. through patient records going missing, not being shared appropriately, or not being immediately accessible), and large amounts of manual transcription result in patient safety issues and significant inefficiencies in care planning and care delivery*’ [9]. This highlights the need for national health policy initiatives to ensure that nations establish and continue to have access to a technical infrastructure that fully supports an optimum use of individual EHRs.

The European Commission’s SemanticHEALTH roadmap underlines that ‘issues of technical standardisation are no longer the most prominent ones in realising the interoperability vision’ Lakovidis [10] noted that “*interoperability is not just a technical and standardization challenge. It involves as well leadership, decisions about and investment in political, institutional, organizational, legal and market issues*”. This report predicts that “*distributed care will become the dominant paradigm with a rapid shift of care both to the community and to highly specialized centres applying the latest techniques*

*arising from accelerated clinical and translational research. Care in remote areas will be particularly affected” and “Public health will be facilitated by much faster and less costly collection of regional, national and international statistics as most statistics will be derived from data collated during patient care” and “Clinical and translational research will advance very rapidly”* [11] (p.13).

#### 1.4. Semantic interoperability and standards

A US physician recently noted that:

*‘Right now the IT systems we have in use are essentially transactional systems that support actions such as ordering a lab test or documenting the administration of a medication, rather than cognitive support systems that help clinicians sort through data to think more clearly about critical health care decisions’* [12]. There is general agreement that only when the highest possible level of interoperability is achieved between clinical systems can a receiving system ‘understand’ the information transferred in the same context and meaning as the information sender. It’s about maintaining semantics in a manner that enables users to trust any system’s data as system vendors do not have a legal responsibility for any system errors that may compromise patient safety [13] that remains a user responsibility. Clinical information systems need to be able to reliably manage its data in a manner that enables its re-use via further computer processing, a prerequisite to developing and using decision support systems as well as enabling its use for multiple other purposes. Meeting these functional needs, purely from a technical perspective, requires the support of valid and reliable computer processing that can only be realised if an adequate set of agreed national standards are adopted and fully complied with by all health information systems and various business processes. What are these key standards?

How does one go about deciding which set of standards to adopt?

One suggested way of deciding which set of standards to adopt nationally is to consider the desired functions as these determine the degree or level of interoperability required. If a nation desires to have fully semantically informed systems with engineered interoperability, as is required for the adoption of EHRs, then one needs to adopt a set of standards that in software engineering terms ‘define a framework for defining reusable formal clinical content models, that can be used with abstract generic schemas to be able to generate various concrete generic schemas, and to generate concrete purpose-specific concrete schemas [14]. Beale described four frameworks within a suggested standards typology where each framework essentially refers to the degree of interoperability that can be achieved following the set of standards within each framework. What needs to be understood is that there are qualitative differences between each standards framework adopted in terms of health budget impact, where each framework (set of standards adopted) brings significantly different advantages and cost characteristics.

Achieving a high degree of semantic interoperability for clinical information exchange is the most challenging but necessary outcome of any e-health implementation strategy as this enables the successful adoption of birth to death EHRs. These in turn are essential building blocks to enable health professionals and consumers to make the best possible use of available information, knowledge and communication technologies at the point of care. A further flow on effect is attaining a sustainable health system.

It is recognised that many current transactional systems as well as cognitive support systems in current use do serve a useful role but they need to be integrated to improve their benefits. Any degree of interoperability is better than none. The adoption of any of the standards frameworks

described in Beale's topology other than the set of standards framework described previously as that required to unlock the full potential benefits of EHRs, needs to be viewed as a transitional arrangement that makes the best possible use of existing (legacy) systems. This paper argues that the adoption of semantically interoperable health information systems is essential to realise EHRs able to function in accordance with the ISO definition of an 'Integrated Care Electronic Health Record'. This realisation is dependent upon political decisions regarding standards adoption and e-health implementation strategies. Each nation needs to have such a vision to work towards preferably over a predetermined and realistic time-frame.

## 2. What are electronic lifelong health records or EHRs?

An extensive review of the research literature on EHR systems found that very few papers offered descriptions of the structure of EHRs [15]. This review revealed that the literature tends not to clearly differentiate between systems or applications using EHR data versus the records (data repositories) themselves. Yet from a semantic interoperability perspective it is imperative that we all adopt the same structure or data or object model, referred to as reference models, for the record itself [16]. An ideal objective perhaps but once clinicians fully appreciate the importance they will demand it.

This literature review did not identify this as having been featured in any of the studies reviewed. Most EHR studies reported were about EHRs located and used in one organisation as opposed to lifelong records that need to be able to accommodate data collected from multiple providers and devices in various locations via distributed systems over a time span that is greater than one episode of care. It was also apparent that many of the EHR studies included in the review

were in essence about EHRs as used within specific departments. In other words there was little if any interoperability between departments within one organisation. This lack of enterprise wide interoperability was also found during a recent US study [17].

The "Integrated Care Electronic Health Record" (EHR) is defined by the International Organization for Standardization (ISO TR 20514:2004) as:

*"...a repository of information regarding the health of a subject of care in computer processable form, stored and transmitted securely, and accessible by multiple authorised users. It has a 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."*

The business drivers identified earlier indicate that we need to adopt EHRs from birth as these records are expected to contain all of the fundamental data to be used by any health information system in use throughout the health industry. Such records need to be shareable by clinicians to enable them to provide timely, comprehensive and coordinated healthcare. This requires the standardisation of clinical content to allow accurate and semantically computable health information flow. That is clinical data needs to retain its context to ensure the meaning remains constant.

The national adoption of EHRs can only be successful within a framework that provides national governance, authorisation and security measures. In addition there needs to be capacity to integrate clinical guidelines with clinical systems and the ability to provide decision support. This requires the guidelines to be produced in a computable format able to integrate into every proprietary clinical system. The standardisation of clinical content is extraordinarily difficult to achieve as clinical needs and requirements for shared EHRs con-

tinue to evolve and change. In other words the clinical knowledge domain is complex and dynamic. One could argue that until there is wide agreement on the standardisation of content and e-record structures, it is not possible to hold one's entire health record as a personal health record (PHR) [18]. There is a need to separate detailed data needed to support the care of one ill health episode such as immediate post operative observations (vital signs data) from data that may provide useful knowledge to inform and support the management of future ill health episodes. An analysis of what these descriptive definitions mean in practical terms [19] reveals that an EHR has the following characteristics:

- The EHR is **patient-centred**: one EHR relates to one subject of care, not to an episode of care at an institution;
- The EHR is **longitudinal**: it is a long-term record of care, possibly from birth to death;
- The EHR is **comprehensive**: it includes a record of care events from all types of carers and provider institutions tending to a patient, not just one specialty; in other words all important care events of any kind are documented in an individual's EHR;
- The EHR is **prospective**: not only are previous events recorded, so is decisional and prospective information such as plans, goals, orders and evaluations.

Another very desirable, or one could argue essential, characteristic is for EHRs to be accessible for authorised purposes from multiple locations simultaneously. All data contained in EHR repositories need to be able to be securely transmitted and aggregated for data sharing, public health, reporting, practice evaluation, data mining and research purposes. That is, EHRs are dependent upon information exchange and information use also referred to as system interoperability.

### 3. How do EHRs relate to semantic interoperability?

Only integrated individual (personal) health records, also referred to as PHRs, are seen to have ‘true transformative potential to strengthen healthcare consumers’ ability to manage their own health care’ [20]. Integrated PHRs were identified by these authors as being able to improve the quality, completeness, depth, and accessibility of health information provided by patients; enable facile communication between patients and providers; provide access to health knowledge for patients; ensure portability of medical records and other personal health information; and incorporate auto-population of content. Health record integration is dependent upon interoperability.

The IEEE has defined interoperability as “*the ability of two or more systems or components to exchange information and to use the information that has been exchanged*” [21]. This definition does not refer to knowledge exchange where knowledge may be defined as information situated in a particular context. One could argue that all clinical information needs to be viewed in context to enable accurate interpretation or understanding (meaning) of such information. For example the exchange of a patient’s latest blood pressure reading is meaningless without the context of when, how and the purpose for which the blood pressure was measured: it’s about semantics. Data interoperability has also been defined as “*the ability to transfer data to and use data in any conforming system such that the original semantics of the data are retained irrespective of its point of access*”<sup>1</sup>.

Knowledge transfer (semantic interoperability) is currently outside the scope of mainstream interoperability solutions and is an area of active research, particularly within the multi-agent systems community [23] and in health informatics. There are a number of definitions for semantic interoperability [24,25,26].

Elkin et al.’s [26] ontology of interoperability is the most comprehensive, and describes the various degrees of interoperability relative to specific application needs and required functions in terms of syntactic, semantic and pragmatic interoperability. Ontologies define the basic terms and relations of a domain of interest as well as the rules for combining these. Elkin et al. have defined eleven levels of semantic interoperability within the interoperability domain, as listed below:

- 1) Free text
- 2) Free text with fixed data types
- 3) Codification of data by local codes
- 4) Codification of data by nationally standard aggregate codes
- 5) Codification of data by nationally standard detailed coding system allowing both atomic and pre-coordinated concepts
- 6) Codification of data by nationally standard detailed coding system allowing post-coordination (based on formal logic)
- 7) Model based knowledge representation with local codes
- 8) Model based knowledge representation with nationally standard aggregate codes
- 9) Model based knowledge representation with nationally standard detail allowing both atomic and pre-coordinated concepts
- 10) Model based knowledge representation coordinated semantically nationally standard detailed coding system allowing post-coordination (based on formal first order logic)

Free text is used for natural language processing. Some would argue that this should not be included as a level of semantic interoperability as the context of meaning, purpose, completeness or form is questionable. Nevertheless this ontology highlights the fact that a high level of semantic interoperability is not required for all health systems, it’s dependent upon desired functionality. In a number of instances technical/syntactical interoperability is sufficient to meet the purpose. However a high level of semantic interoperability is required to enable management and processing

of all knowledge intensive clinical data such as data stored in EHRs. It is about representing clinical knowledge in a form that permits consistent knowledge transfer, thus enabling accurate machine processing by the receiving system for applications such as decision support.

#### 3.1. Roles between reference model, archetypes structure, data types and terminology

The key requirements to achieve semantic interoperability are:

- 1) a suitable reference model and data types,
- 2) Clinical knowledge models (archetypes),
- 3) terminology and
- 4) unique identifiers.

There are strong relationships between the first three characteristics: full semantic interoperability requires clarification of the roles of the reference model, data types, archetypes structures and terminology. A reference model is an abstract representation of data or information entities or objects and their relationships for a specific problem space (domain) such as an EHR. Reference models provide frameworks for the desired system architecture for a specified domain by providing a common conceptual framework that can be used consistently by different systems. The reference model needs to reflect the ontology of the domain modelled to ensure there is no redundancy. Where reference models do not share the same domain ontology, such as EHRs vs EHR systems, and/or the representation of either the same entities or objects, then there is no consistency between them in terms of entity vs objects and their relationships.

It is important to recognise that ‘entities’ refer to different constructs than ‘objects’. Entities are ‘classes’ consisting of properties alone, whereas ‘objects’ consist of not only properties but they also include ‘methods’ or ‘processes’. Consequently there is a significant difference between a ‘ref-

reference information model' that represents entities and their relationships such as the HL7 v3 RIM and a 'reference object model' representing defined objects and their relationships such as the openEHR RM. From an EHR domain perspective, objects represented in a reference object model define reusable formal clinical content models. Such a system architecture enables full semantic interoperability to be achieved, whereas systems structured to comply with entity based reference models are largely transactional requiring considerably more technical development of interfaces to achieve various degrees of semantic interoperability between systems.

There has been a lot of discussion regarding the need to adopt standard terminologies to enable data transfer to be achieved. The SNOMED CT terminology has been widely accepted as the most comprehensive and appropriate, however it is worth noting that its adoption is classed as level 5 in Elkin's interoperability ontology and defined as "codification of data by nationally standard detailed coding system allowing both atomic and pre-coordinated concepts". The use of a standard terminology has the same limitations as the adoption of 'entities' in reference information models. Terminologies have 'properties' whereas Archetypes, as defined by the openEHR foundation consist of properties as well as 'methods' or 'processes' and/or 'constraints'. That is Archetypes are models that represent knowledge in context enabling their use for achieving the highest level of semantic interoperability.

The concepts included in these models need to be represented in accordance with a standard set of data types and be bound to a standard terminology to fully meet this requirement. It follows that there needs to be a governance infrastructure to endorse and manage standard archetypes in respect of their precise representation of current clinical knowledge and terminology binding as there is for the maintenance of con-

trolled terminologies such as SNOMED-CT. It is only when archetype definitions are represented in a standardised form that these models can be shared and used across record sharing communities for the purpose of defining how locally organised clinical data should be mapped consistently [26].

In addition to reaching an agreement about the vocabulary used, the use of any clinical knowledge model needs to be referenced to an information or object reference model representing specific domain object (clinical) models using a set of standard class names representing those found in a life long patient record. Adopting a distributed object approach to achieve system interoperability, means that not only does there need to be agreement regarding object class names as presented in the reference model but there also needs to be an agreement regarding the class interfaces. In other words there needs to be a standard EHR information (object) reference model as this forms the basis against which instances of clinical data in the real world can be modelled.

Unfortunately we continue to purchase proprietary systems where each has its own reference model and we have several different standard reference models with different scope. As a consequence the much needed high level semantic interoperability cannot be achieved. Consequently we are failing to meet the needs of clinicians<sup>7</sup>. Basic differences in the reference model and associated techniques, drive subsequent differences in clinical model design, modelling and implementation. Convergence is difficult if not impossible to achieve unless the most expressive form is taken as the base specification or a whole new more generic modelling approach, independent of any existing reference models, is developed. Such an approach must ensure that authored clinical models can be automatically transformed to be used with existing reference models. This is a major technical undertaking and may

not be possible. A large work program that does not deliver tools and an environment that supports clinical involvement and formal expression will not assist semantic interoperability.

### 3.2. Unique identifiers

It is critical that an accurate match between clinical information collected and the record is achieved when any patient information is transferred to a health record for storage and use to ensure that these two entities both belong to the same patient. This is achieved via the adoption of unique patient identifiers. Similarly it is necessary from a legal and quality perspective that all healthcare documentation is linked to the healthcare provider responsible for its collection. Healthcare providers may be individuals and where services are provided within an organisation such as a hospital, the relevant the organisation (legal entity). Again this is achieved via the adoption of unique provider identifiers. Both need to be well governed to ensure each identity relative to the identifier is correct at all times, that is each identifier is allocated to real living persons and legally constituted healthcare organisations. The linkage of incorrect identifiers to clinical data compromises patient safety as well as provider liabilities.

Frisse [27] confirms the need for identity governance, he notes that there is a need to focus on functional components to ensure for example that 'identities cannot be stolen and used to access personal health information, that data are transmitted and presented reliably, that communications are secure, and that transactions are inexpensively audited' by means of functional component certification. It's about ensuring that the building blocks used enable the many software applications to reliably communicate with each other. This requires Government direction regarding the establishment of a suitable national infrastructure

#### 4. National eHealth strategies and political decision making

Following the adoption of the WHO's e-health resolution at the 58<sup>th</sup> World Health Assembly [28 numerous member nations have developed their own national eHealth strategy. Such strategies are the result of political decision making and reflect various health policy initiatives. We need to examine such plans relative to core business and technology characteristics that are known to be fundamental to achieving a high level of semantic interoperability between distributed systems such as a standard reference model, the national adoption of a standard set of data types, unique consumer and provider identifiers, national standard clinical data models (archetypes), common business processes between healthcare organisations and the States. Ideally national e-health strategies enable not only the implementation and effective use of EHRs but also enable automated reporting and other additional functions once implemented.

Some legacy systems have been in existence for decades, and as time goes on, the expertise or resources to maintain them diminish – a classic sustainability trap. Further, the introduction of a new system will often demand that it interface with all relevant existing systems. Interfaces have the characteristic that their growth is a factorial in the number of systems communicating - another sustainability trap. It quickly becomes clear why standards, and adherence to standards, is an essential strategy to get away from a growing burden of legacy systems, and an accumulation of interfacing and maintenance tasks that have the potential to overwhelm an IT support organisation over time [29].

The Australian Federal and State Governments established a National eHealth Transition Authority (NeHTA) in 2004 to drive its national directions. Goals included the development of better ways of electronically collecting and securely exchanging health information for the

purpose of improving health care services, streamlining multidisciplinary care management, and improving clinical and administrative efficiency whilst maintaining high standards of patient privacy and information security. There has been a tendency to focus on enabling electronic transactions rather than on achieving semantic interoperability. This is a sound transitional strategy to make the best possible use of existing systems. What appears to have been missing is a national future vision of achieving a high level of semantic interoperability together with the necessary work program that establishes the infrastructure not only to support all transitional arrangements but also to support this future vision including the necessary governance infrastructure.

In 2007 NEHTA published its selection of a national 'document/services-centric HL7 v3 approach as the preferred longer term direction, complemented by support for continued use of HL7 v2.x' following a previously commissioned review and feedback from stakeholders [30]. There appears to have been scant attention and at best poor understanding of how best to meet semantic interoperability requirements as the key characteristics previously described were hardly mentioned: they were certainly not identified as being critical. Interestingly the European Commission noted two years later that 'In countries where it is mandated, large and unwieldy approaches such as SNOMED CT and HL7 v3 will become taxes on healthcare, absorbing significant resources while returning no, or in some case even negative benefits [31].

This has been well demonstrated by the UK National Health Service (NHS) experience who also adopted this approach. The 2008-09 report to the House of Commons on the National programme for IT in the NHS noted that its Care Records Service is at least four years behind schedule and that 'little clinical functionality has been deployed to date, with the result that the expectations of

clinical staff have not been met [32]. The NHS has found that in order to exchange care record information, it should be collected and recorded according to consistent rules and that clinical terminology standards on its own does not ensure that a clinical encounter is recorded with enough precision to be retrieved and interpreted by multiple information systems<sup>9</sup>. Indeed, this is the major issue associated with the strategy adopted; accurate clinical data flow between distributed systems is extremely difficult to achieve unless the key characteristics of semantic interoperability are met by the standards approach adopted. In other words the failure to address this will result in an increasing financial burden and an unsustainable health system resulting from the inability to optimise the use of information and communication technologies in the health industry. The NHS is now busy developing its own Logical Record Architecture for Health and Social Care. It is intended to be the national care records data standards framework for documenting, using and re-using care record data requirements and their associated technical specifications. The Australian Governments' latest National e-health Strategy was developed by the Deloitte consulting firm with the assistance of input from numerous stakeholders. It was endorsed by all Australian health ministers and released in December 2008 [33]. It notes the need for a good national broadband infrastructure as without this e-health strategies cannot be successfully implemented. Their national vision is stated as:

*"eHealth will enable a safer, higher quality, more equitable and sustainable health system for all Australians by transforming the way information is used to plan, manage and deliver health care services".*

This strategy's recommendations include many of the key requirements but appear not to have recognised the fundamental need for an agreed record structure (reference model) or for the need to establish a professional clinical governance infrastruc-

ture, yet it is actively promoting the adoption of individual electronic health records. One could argue that the realisation of this future vision requires an infrastructure that supports a high level of semantic interoperability although this isn't clearly stated. The Governance principles included are clarity of accountability, transparency, appropriate stakeholder representation, sustainability, support for activity at multiple levels, effective leadership and coordination and balance of local innovation and national outcomes. It should be noted that the need to establish a sound governance infrastructure regarding identifiers, clinical knowledge and technical standards compliance as described previously is not mentioned. The need to certify clinical systems is also missing, this is an issue given that system errors may compromise patient safety. The focus of this strategy is essentially political in terms of required policy initiatives but it has not appropriately grasped clinical or key technical requirements. One could argue that the latter is NEHTA's job, but both groups' directions need to be harmonised. This is an example of the difficulties encountered when various entities within one country take on the responsibility for certain aspects of e-health strategy implementation but not for others. It complicates harmonisation efforts in a way that easily results in errors, duplication or omissions.

## 5. Conclusion

Generally speaking, Governments have no difficulty in describing their vision for a future sustainable health system. Increasingly there is a realisation that the only way to achieve this is via the adoption of EHRs. What is missing is a sound understanding and appreciation of specific national infrastructure needed to support and enable such health reform, or how to realise the best possible use of available information, communication and knowledge management technologies.

This paper has argued that full semantic interoperability cannot be achieved without clarity of roles of the reference model, data types, archetypes structure and terminology. In other words standards associated with these concepts need to be seen as a set of standards or framework as described in a standards typology. What we are witnessing is a diversity of systems where each complies with its own set of standards which may or may not collectively fit within one national framework. The result is interoperability to some degree that incurs large development and maintenance costs. These are essentially transaction systems and do not meet the needs of clinicians. The latter also results in a nation's inability to realise its health reform mission. Large corporate software developers and suppliers have invested many millions of dollars over many years. They have continued to build on system architectures developed in most instances 10 to 20 years ago when we didn't have today's technologies or the knowledge and experiences now well documented. Even where it is recognised that ideally their system architectures should change such companies will not make such changes unless compelled to do so over a stated period of time. Only political initiatives can do this. Such actions are required for the public common good. Our current eHealth strategies are simply not sustainable in the long term.

A national standards framework needs to be designed to enable a high level of interoperability to be achieved. It is imperative that we as a nation are able to maximise the benefits to be achieved from these new technologies. That, in conjunction with a suitable national governance infrastructure, will facilitate not only the successful adoption of EHRs at scale but also the ability for many software suppliers to contribute applications meeting very specific niche requirements that are essentially plug and play. Only then will we be in a position to fully meet a nation's health care system vision. It's time for Health Informatics experts to educate the decision makers and lobby

Governments to adopt strategies designed to implement the necessary changes in conjunction with associated health reforms.

## References

1. Australian Institute of health and Welfare, Australia's Health 2008, Canberra p.10 <http://www.aihw.gov.au/publications/aus/ah08/ah08-c08.pdf>
2. Australian Institute of health and Welfare, Australia's Health 2008, Canberra p.47 <http://www.aihw.gov.au/publications/aus/ah08/ah08-c08.pdf>
3. Coeira E, Hovenga EJS Building a sustainable health system in: IMIA Yearbook of Medical Informatics 2007, Schattauer, Stuttgart
4. Dawes S, Cresswell A, Pardo T, Tompson F. Modeling the social and technical processes of interorganisational information integration. ACM International Conference Proceedings Series - Proceedings of the 2005 national conference on Digital government research. 2005;89:289-90.
5. Brown A, Grootjans J, Ritchie J, Townsend W, Verrinder G. Sustainability and Health - Supporting Global Ecological Integrity in Public Health. Alan and Unwin; 2005.
6. Shediak-Rizkallah MC, Bone LR. Planning for the sustainability of community-based health programs: conceptual frameworks and future directions for research, practice and policy Health Education Research. 1998;13(1):87-108
7. Ball MJ, Silva JS, Bierstock S, Douglas JV, Norcio AF, Chakraborty J, Srinii J. Failure to provide clinicians useful IT systems: opportunities to leapfrog current technologies, Methods of Information in Medicine. 2008; 47(1):4-7.
8. Wilder B. Adoption of open-sourced EHR technology leads to efficiencies, safety and quality care. Getting beyond economics, 2007;11(8):49. <http://health-care-it.advancweb.com/editorial/content/editorial.aspx?CC=170503>
9. Lunn K, Sato L, Bentley S. Achieving Data Interoperability through the Logical Record Architecture version 0.1, NHS Connecting for Health. 2008. <http://www.connectingforhealth.nhs.uk/systemsandservices/data/lra>
10. Iakovidis I. Foreword, in SemanticHEALTH Report, Semantic Interopera-



- bility for better health and safer healthcare, European Commission, Information Society and Media. 2009, p.5 [http://ec.europa.eu/information\\_society/ehealth](http://ec.europa.eu/information_society/ehealth)
11. European Commission, SemanticHEALTH Report, Semantic Interoperability for better health and safer healthcare, European Commission, Information Society and Media. 2009, p.13 [http://ec.europa.eu/information\\_society/ehealth](http://ec.europa.eu/information_society/ehealth)
  12. Sim I, Director of the Center for Clinical and Translational Informatics at the 'University of California, San Francisco quoted by Friedrich MJ. 2009 Report Aims to Reboot Health Care IT in JAMA March 18 2009;301(11):1116 <http://jama.ama-assn.org/cgi/content/full/301/11/1116>
  13. Koppel R and Kreda D. Health Care Information Technology Vendors' "Hold Harmless" Clause - Implications for Patients and Clinicians, Journal of the American Medical Association 2009;301(12):1276-1278.
  14. Beale T.A standards typology, email message to the openEHR-clinical list. 6 Sept 2008.
  15. Hayrinen K, Saranto K, Nykanen P. Definition, structure, content, use and impacts of electronic health records: a review of the research literature. International Journal of Medical Informatics. 2008;77(5):291-304.
  16. Goossen W. Unpublished report of an invitational Detailed Clinical Models workshop held in Brisbane August 25 2007.
  17. Stead WW, Lin HS, editors. Computational technology for effective healthcare: immediate steps and strategic directions. National Research Council for the national academies, National Academies Press, Washington DC. 2009; p.1-5 [http://www.nlm.nih.gov/pubs/reports/comptech\\_prepub.pdf](http://www.nlm.nih.gov/pubs/reports/comptech_prepub.pdf)
  18. Hovenga EJS, Heard S.eHealth records and Future Healthcare in: Hovenga EJS, Kidd M, Garde S, Hullin C, editors. Health Informatics - an overview. Forthcoming.
  19. Garde S, Knaup P, Hovenga E, Heard S: Towards Semantic Interoperability for Electronic Health Records: Domain Knowledge Governance for openEHR Archetypes. Methods of Information in Medicine. 2007;46(3): 332-343. <http://dx.doi.org/doi:10.1160/ME5001>
  20. Detmer D, Bloomrosen M, Raymond B, Tang P. Integrated Personal Health Records: Transformative Tools for Consumer-Centric Care. BMC Medical Informatics and Decision Making. 2008 Oct 6;8:45 <http://www.biomedcentral.com/1472-6947/8/45>
  21. IEEE. IEEE Standard Computer Dictionary: A Compilation of IEEE Standard Computer Glossaries. New York: IEEE Press; 1990.
  22. Qamar R, Rector A, 2007 Semantic issues in integrating data from different models to achieve data interoperability. In: Kuhn K, Warren J, Leong TY, editors. Medinfo2007: conference proceedings. Amsterdam: IOS Press; 2007. p.674
  23. Jarvis D, Jarvis J. Interoperability in: Hovenga EJS, Kidd M, Garde S, Hullin C, editors. Health Informatics - an overview. Forthcoming.
  24. Information Management Strategy Committee. Australian Government Information Interoperability Framework: sharing information across boundaries. Sydney: AGIMO; 2006. [http://www.agimo.gov.au/\\_data/assets/pdf\\_file/50725/Information\\_Interoperability\\_Framework.pdf](http://www.agimo.gov.au/_data/assets/pdf_file/50725/Information_Interoperability_Framework.pdf)
  25. Walker J, Pan E, Johnston D, Adler-Milstein J, Bates DW, Middleton B. The value of health care information exchange and interoperability. Health Affairs. 2005 Jan 19. <http://content.healthaffairs.org/cgi/content/full/hlthaff.w5.10/DC1>
  26. Elkin PL, Froehling D, Bauer BA, Wahner-Roedler D, Rosenbloom ST, Bailey K, Brown SH. Aequus communis sententia: defining levels of interoperability. In: Kuhn K, Warren J, Leong TY, editors. Medinfo2007: conference proceedings. Amsterdam: IOS Press. Stud Health Technol Inform. 2007;129(Pt 1):725-9.
  27. Frisse ME. Health Information Technology: One step at a time, Health Affairs. 2009; 28(2): w379-w384 . <http://content.healthaffairs.org/cgi/content/abstract/hlthaff.28.2.w379>
  28. World Health Organization. Resolutions and Decisions WHA58.28. Geneva: WHO; 2006. Available from: [http://www.who.int/gb/ebwha/pdf\\_files/WHA58-REC1/](http://www.who.int/gb/ebwha/pdf_files/WHA58-REC1/)
  29. Coeira E, Hovenga EJS Building a sustainable health system in: IMIA Yearbook of Medical Informatics 2007, Schat-tauer, Stuttgart
  30. NEHTA. Standards for e-Health interoperability, an e-health transition strategy version 1.0. 2007; p.8 [http://www.nehta.gov.au/component/docman/doc\\_download/252-standards-for-e-health-interoperability-v10](http://www.nehta.gov.au/component/docman/doc_download/252-standards-for-e-health-interoperability-v10). European Commission, SemanticHEALTH Report, Semantic Interoperability for better health and safer healthcare, European Commission, Information Society and Media 2009; p.14 [http://ec.europa.eu/information\\_society/ehealth](http://ec.europa.eu/information_society/ehealth)
  31. UK House of Commons, Public Accounts Committee, The National Programme for IT in the NHS: progress since 2006, second report of session 2008-09. 2009; p.6. <http://www.publications.parliament.uk/pa/cm200809/cmselect/cmpubacc/153/153.pdf>.
  32. Australian Health Ministers' Conference. National E-Health Strategy Summary. 2008. [http://www.ahmac.gov.au/cms\\_documents/National%20E-Health%20Strategy.pdf](http://www.ahmac.gov.au/cms_documents/National%20E-Health%20Strategy.pdf)

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