Texto & Contexto Enfermagem
ISSN: 0104-0707
texto&contexto@nfr.ufsc.br
Universidade Federal de Santa Catarina
Brasil

Hovenga, Evelyn Johanna Sophia
Importance of achieving semantic interoperability for national health information systems
Texto & Contexto Enfermagem, vol. 17, núm. 1, janeiro-março, 2008, pp. 158-167
Universidade Federal de Santa Catarina
Santa Catarina, Brasil

IMPORTANCE OF ACHIEVING SEMANTIC INTEROPERABILITY FOR NATIONAL HEALTH INFORMATION SYSTEMS

IMPORTÂNCIA DO ALCANCE DA INTEROPERABILIDADE SEMÂNTICA PARA OS SISTEMAS NACIONAIS DE INFORMAÇÃO EM SAÚDE

LA IMPORTANCIA DEL ALCANCE DE LA INTEROPERABILIDAD SEMÁNTICA PARA LOS SISTEMAS NACIONALES DE INFORMACIÓN EN SALUD

Evelyn Johanna Sophia Hovenga[1]

[1] Registered Nursing. Management & Information Systems, PhD. Fellow of the Royal College of Nursing Australia (FRCNA). Fellow of the College of Health Service Executives (FCHSE). Fellow of the Australian College of Health Informatics (FACHI). Fellow of the Australian Computer Society (FACS). Consultant, openEHR Foundation. Consultant Honorary Senior Research Associate, Centre for Health Informatics & Multiprofessional Education, University College London. Honorary Academic Fellow, Austin Health, Melbourne, Australia.

KEYWORDS: Computerized medical records systems. Delivery of health care. Health policy.

ABSTRACT: This reflective paper examines relationships between the Government policy-makers in health; health care providers in general; and the adoption of health care information, knowledge, and communication technologies. These technologies include the adoption of a national health language and computer science standards in health. These reflections are based on the author's observations and international involvement in the development of standards and in the development of national Government Health Information Comunication Technology implementation strategies over many years. A number of critical concepts appear to be poorly understood by key decision-makers. Alternatively, the political agendas and the need to look after a variety of vested interests continue to dominate. It is concluded that we must establish and actively promote a sound business case for the adoption of a national health computer science strategy that is based on the best available scientific evidence that supports a sustainable health system.

PALAVRAS-CHAVE: Sistemas computadorizados de registros médicos. Assistência à saúde. Política de saúde.

RESUMO: Este *paper* reflexivo examina, de modo geral, as relações entre os dirigentes governamentais das políticas de saúde, dos prestadores de cuidado em saúde e a adoção das tecnologias de conhecimento, comunicação e informação de cuidado em saúde. Estas tecnologias incluem a adoção de estruturas de linguagem nacional de saúde e de padrões da ciência da computação. Estas reflexões são baseadas nas observações dos autores e na participação internacional no desenvolvimento dos padrões e no desenvolvimento e implementação das Tecnologias de Informação e Comunicação Governamentais durante muitos anos. Um número de conceitos críticos parece ser mal compreendido pelos responsáveis pela tomada de decisões chaves ou, alternativamente, pelas agendas políticas e pela necessidade de cuidar de uma variedade de interesses próprios que continuam a dominar. Conclui-se que devemos estabelecer e ativamente promover um sólido exemplo profissional, para a adoção de uma estratégia nacional de informática em saúde que seja baseada na melhor evidência científica disponível, e que apóie um sistema de saúde sustentável.

PALABRAS CLAVE: Sistemas de historias clínicas informatizadas. Prestación de atención de salud. Política de salud.

RESUMEN: En el presente artículo se examina de manera general las relaciones entre los dirigentes gubernamentales de las políticas de salud, de los proveedores de cuidado en salud y la adopción de las informaciones de cuidado en salud, así como de las tecnologías de comunicación y conocimiento. Esas tecnologías incluyen la adopción de estructuras de lenguaje nacional de salud y los patrones de informática en salud. Reflexiones esas que están basadas en las observaciones de los autores y en la participación internacional en el desarrollo de los patrones y en el desarrollo e implantación durante muchos años de las Tecnologías de Información y Comunicación Guvernamentales. Un considerable número de conceptos críticos parece ser mal comprendido por los responsables por la tomada de desiciones claves o, alternativamente, por las agendas políticas y por la necesidad de cuidar de una variedad de intereses propios que continuan dominando. Se concluye que nosotros debemos establecer y promover activamente un sólido ejemplo profesional para la adopción de una estrategia nacional de informática en salud que esté basada en la mejor evidencia científica disponible para apoyar un sistema de salud sustentable.

Evelyn Johanna Sophia Hovenga
Address: 12 Sleipner Street, Mt Archer
Rockhampton North Qld 4701
Melbourne - Australia
E-mail: ehovenga@bigpond.com

Reflexão teórica
Recebido em: 15 de julho de 2007
Aprovação final: 15 de fevereiro de 2008

WHAT IS A SUSTAINABLE HEALTH SYSTEM?

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. Some countries do this better than others, but shortcomings are everywhere. Some rationing may occur so that only certain ill health conditions can be treated for all, in other instances only the rich or those who are insured or who are in specific locations can access certain treatments. Many national health systems only service ill health episodes and do not invest in preventative care, including public health, occupational health and safety or road safety measures. Most people are not well educated about health so that their lifestyles contribute to high incidences of ill health, and they are not well placed to manage their own health. Despite these shortcomings, population health overall has improved and the world is experiencing longer life spans for most citizens although this varies significantly. In Brazil this has improved from a life expectancy at birth in 2002 of 57 for males and 62 for females to 68 and 75 respectively in 2007.[1]

With a larger ageing population we are also experiencing the need to manage more people with chronic diseases.[2] That means they need a variety of health services from many different health care providers over long periods of time. This need challenges effective continuity of care especially for more mobile populations. Thus the need to balance the many factors contributing to any nation's health system in a way that enables its continued existence is a huge challenge faced by every nation. There is little research available to identify the characteristics of these factors or how best to create this much needed national balance. Sustainable organization research is an evolving discipline. According to the World Business Council for Sustainable Development (WBCSD) "nearly everyone agrees that the way we manage health today is unsustainable – it costs more than we can afford, and delivers less than we expect".[3:2] The WBCSD has adopted three pillars, economic growth, ecological balance and social progress to guide sustainable activities.[4] Boxer argues that all business leaders need to promote and adopt a sustainable way of operating to achieve organisational survival.[4]

Only sustainable health systems are able to meet demand and provide access to quality health services to the nation's entire population.[5] The World Health Organisation (WHO) does collect a lot of relevant statistics for its 193 member countries that enables the monitoring of impact when significant changes are made to any nation's health service infrastructure. By 2020, any nation's health system will have to treat proportionately more people, with more illness, higher expectations, often using more expensive technologies, and using relatively fewer tax dollars and workers. This paper argues that good use of available information, knowledge and communication technologies can make a significant contribution towards achieving a sustainable health system and that the adoption of semantically interoperable health information systems and birth to death electronic health records will optimize such an outcome.

How can health Information Communication Technology contribute to achieving a sustainable health system?

There is a need to balance the demand for health services with the resources available and still achieve optimum outcomes, namely a healthy population. Today's health care needs to be team-oriented, technology-facilitated, informatics-supported and evidence-based in accordance with modern scientific principles.[6] Consequently it is suggested that the business drivers for a sustainable health system are those drivers that reduce the demand and enhance the provision of quality care in a timely manner in accordance with the adoption of this scientific method. These drivers are identified as follows:

- electronic lifelong health records for every individual so that all the necessary information needed for the provision of quality treatment to any individual for any specific health episode is available anywhere and anytime;

- ability to provide the necessary continuity of care across multidisciplinary provider, organisational, country, language, and time boundaries via the valid electronic transfer of data, information and knowledge;

- an educated population able to manage their own preventative care to reduce the demand for health services;

- availability of an appropriately educated health professional workforce, health care technologies and other resources to meet demand enabling the provision of the most appropriate evidence based care, patient safety maintenance and a reduction in errors;

- use of these national de-identified data for public health and disaster management purposes;

- safe home, work and travel environments to reduce the demand for health services.

To meet these 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 to be realised from ehealth, some are far more advanced than others, all have identified these drivers as significant to various extents, all have encountered a number of difficulties so we can learn from those experiences. For example HealthLink, a public/private partnership started in 1993 specialising in the development of e-health infrastructures and services for New Zealand, Australia and Canada. It's current Chief Executive, Tom Bowden recently noted that unimplemented infrastructure and standards are preventing integration companies from delivering new services. He highlighted three main issues that prevented this realisation, a lack of national strategic direction, a lack of clarity about the government's role in Informatics Technology (IT) and a lack of funding.[7] Other national Governments have addressed these issues to some extent in a number of ways.

The Australian federal and State Governments have established a National eHealth Transition Authority a few years ago to drive its national directions towards 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, improving clinical and administrative efficiency whilst maintaining high standards of patient privacy and information security. A new strategic plan for 2008 has just been released.[8] Similarly Canada's HealthInfoway was created in 2001 as the catalyst for collaborative change to accelerate the use of electronic health information systems and Electronic Health Records (EHRs) across that country.[9]

Scotland has just announced a new eHealth strategy for implementation in 2008 with a focus of joining up systems where they can see clear benefits of doing so.[10] The National Health Service (NHS) in the United Kingdom (UK) began implementing their Connecting for Health strategy in 2005. The agency managing this is about supporting the NHS to deliver better, safer care to patients, via new computer systems and services, that link General Practitioners (GPs) and community services to hospitals, and to maintain the national critical business systems provided previously by the former NHS information authority.[11]

The United States of America (USA) has left the eHealth implementation to individual communities and companies, so their implementation is very fragmented as demonstrated by one recent survey on eHealth initiatives.[12] The USA Office of the National Coordinator for Health Information Technology will soon release a five-year strategic plan detailing the national health-IT agenda for 2008 implementation. Their vision is interoperable health IT by 2014.[13]

Many nations have now developed a Health information or e-health strategy arguing that using state of the art technologies contributes significantly to the development of a sustainable health system. Such development requires successful coordination, integration and sharing of information in a context of changing work processes, significant organizational change and forever changing political and institutional environments. The WHO requests international collaboration, for example via the many Health Informatics standards development activities. In part these developments have resulted from the WHO's eHealth resolution and decision adopted by its 193 member countries at the 58th World Health Assembly in 2005, although for most nations eHealth is in its infancy. WHO stressed that eHealth is about cost-effective and secure use of information and communication technologies in support of health and health-related fields, including healthcare services, health surveillance, health literature and health education, knowledge and research.[14] WHO urged its member countries to adopt the final resolutions to collaborate and deliver EHRs. Previously WHO had noted that strengthening knowledge systems by sharing information and experiences could produce a dynamic, innovative effect in the areas where health issues are most critical.[15] These events do indicate a global consensus view supporting the business drivers as identified previously, that should be used to guide the development of a national eHealth strategy.

What should a national eHealth strategy consist of?

For healthcare to be sustainable, we need to close the loop between the flows into and out of the system. Health systems are complex, highly connected social constructs that control: funding, access to services, workforce supply and demand,

availability and cost of drugs, supplies, equipment, physical facilities and technologies, research opportunities and adoption of research results. Health systems also shape consumer expectations and ultimately clinical outcomes. All these processes and outputs are constrained by a nation's political, legal, workplace, cultural, financial and business systems. Thus every nation's unique health system infrastructure, current status of health Information Communication Technology (ICT) adoption, health policy initiatives, political ambitions/philosophies, cultural needs, resource availability and health environment influence the feasibility and timeline for the realisation of a nation's vision of a sustainable health system that reflects its significant health business drivers.

Generally speaking there needs to be a well defined vision, strong national leadership, with participation from all stakeholder groups from people with appropriate Health Informatics expertise, to guide the development and implementation of a national eHealth strategy. Such a strategy needs to include the establishment of the necessary national infrastructure, including the education of key stakeholders and decision makers in health informatics, to support the realisation of the vision as well as clear transitional arrangements integrating all relevant current policy initiatives so that benefits may be realised incrementally over time. However it is important to recognise that information technology is not a universal panacea, and poor design and use of ICT can itself lead to unsustainable practices and system behaviours. ICT is only one component of any clinical service, and not the end goal itself. Sustainable services require significant emphasis on change management and organisational processes.

A NATIONAL HEALTH INFORMATICS INFRASTRUCTURE

An analysis of the business drivers previously identified reveals that the critical system requirements to be supported by health ICT is the ability of systems to validly transfer, aggregate and use health data, information and knowledge for multiple purposes. Therefore a national health informatics infrastructure must be able to support system interoperability. This requires key stakeholders and decision makers to fully understand 'system interoperability' so that they can ensure that systems can meet the necessary criteria. Achieving national health system interoperability requires the adoption of a number of health informatics standards. Such standards need to be governed and managed by a national entity to ensure national consistency but first we'll define system interoperability, this will be followed by an analysis of the types of standards and national health informatics infrastructure required to enable the realisation of the national health business needs.

What is system interoperability

System interoperability is about connectivity and the ability to transfer, share and use data, information and knowledge between systems. It requires an inter-organisational relationship. The Australian Government Interoperability Framework has three parts, the Information Interoperability Framework, the Technical Interoperability Framework; and the Business Process Interoperability Framework as represented in the figure below (See Figure 1).

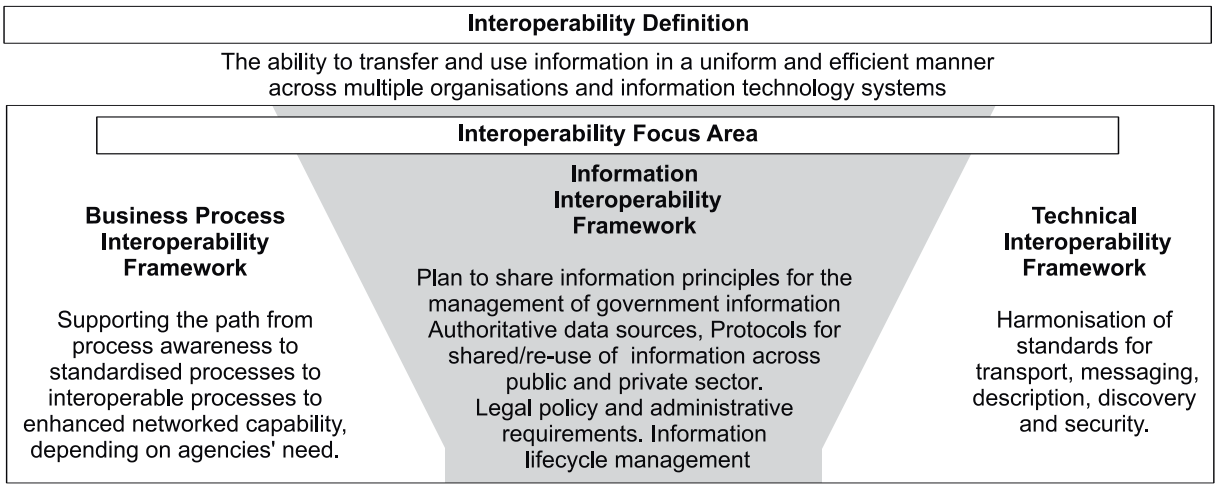

Figure 1 - The Australian Government Interoperability Framework.[16]

Various health informatics standards provide the specifications that need to be complied with to suit specific applications' communication functionality such as for prescription or patient administration Health Level Seven (HL7) messages. The complexity of system interoperability becomes evident when we examine the literature to identify a clear meaning. This explains the poor overall understanding of this concept. There are two papers of significance, one used a taxonomy as the basis for assessing the value of interoperability, the other developed an ontology to describe this domain. Both demonstrate agreement that there are different levels or degrees of interoperability and these determine the functionality.

Walker et al described a four level functional taxonomy of interoperability reflecting the amount of human involvement required, the sophistication of IT, and the level of required standardization to form the basis, to assess the value of electronic health care information exchange and interoperability, as follows:

- level 1: non electronic data −no use of IT to share information (examples: mail, telephone);

- level 2: machine-transportable data − transmission of non-standardized information via basic IT; information within the document cannot be electronically manipulated. Examples: fax or Personal Computer (PC), based exchange of scanned documents, pictures, or Portable Document Format (PDF) files;

- level 3: machine-organisable data − transmission of structured messages containing non-standardized data; requires interfaces that can translate incoming data from the sending organization's vocabulary to the receiving organization's vocabulary; usually results in imperfect translations because of vocabularies' incompatible levels of detail. Examples: e-mail of free text, or PC-based exchange of files in incompatible/proprietary file formats, HL7 messages;

- level 4: machine-interpretable data − transmission of structured messages containing standardized and coded data; idealized state in which all systems exchange information using the same formats and vocabularies. Examples: automated exchange of coded results from an external lab into a provider's Electronic Medical Record (EMR), automated exchange of a patient's "problem list".[17]

There is another way to differentiate between levels and degrees of interoperability. Elkin and his colleagues explain three levels originally described and published by Charles Morries in 1938 as syntactic, semantic and pragmatic. These levels formed the foundation of their ontology of interoperability. Each level supports specific application needs and is described in terms of functionality resulting in various degrees of interoperability within each of these levels. This ontology was then used as evaluation criteria for any existing system or relevant health informatics standard to assess compliance. These three levels of interoperability were described as follows: "syntactic Interoperability deals with interoperable structures. Semantic Interoperability deals with the interoperability of a common shared meaning. Pragmatic Interoperability deals with the external constraints on the system. This last category takes into account the level of granularity needed for common understanding and the complexity or difficulty required to achieve a certain level of interoperability".[18:725] Each level may be analysed into a series of system application requirements that may be met thus further scaling the degrees of interoperability. Syntactic interoperability suits those software applications dependent only on interoperable structure, whereas semantic interoperability is essential for those applications that are dependent upon the ability to process "common shared meanings" via the adoption of data standards or a standard health language.

This difference between the first two levels may be described in terms of the connectivity provided by the Internet versus that provided by the World Wide Web. The Internet transfers packets of information from one computer to another anywhere in the world (structure) but the world wide web is about identifying content, documents, sounds, videos etc. via programs that communicate between computers connected via the Internet using Hypertext Markup Language (HTML) (common shared meanings), in addition it is non-proprietary and free.[19] Many existing clinical applications are able to send or receive messages from another using a standard format (structure) as defined by HL7 messages. They may also incorporate a standard terminology to define common clinical concepts that are incorporated within those messages but this still best equates to syntactic interoperability.

Within syntactic interoperability has been identified and described six degrees of interoperability ranging from "simple headings" to "fixed and formatted hierarchically organized fields with possible structural links indicating non-hierarchical relationships between concepts".[20:728] Semantic in-

teroperability is required for the reliable transfer of clinical data as this is where the meaning of the data must be retained to validly enable the transferred data to be processed by the computer and used for decision support systems. Also has identified eleven degrees of interoperability for this level ranging from 'free text' transfer to the ability to transfer a formal representation of knowledge using higher order logics which can fully support context described as a "model based knowledge representation coordinated semantically nationally standard detailed coding system allowing post-coordination with support for context".[20:729] Walker's interoperability level 4 does not meet the most optimum degree of semantic interoperability as described by Elkin et al whose ontology is more comprehensive.

Irrespective of whether Walker's taxonomy or Elkin et al's ontology for interoperability is adopted, all healthcare applications need to establish the functions they need to be able to perform so that the required degree and level of interoperability can be established enabling the identification of which standard they need to be compliant with. Each nation needs to first of all establish its unique health business requirements followed by the establishment of a national health informatics standards framework as well as a national health language framework. Both frameworks need to be supported by a national governance process to ensure that all health systems are compliant with the required technical and health language standards. Applications within individual organisations need to be able to meet national business requirements as well as their own specific business needs.

Most nations and healthcare organisations seriously engaged with their eHealth strategy implementation have such infrastructures, some more comprehensive and effective than others. Unfortunately the complexity about system interoperability and its link with functionality continues to be poorly understood by most stakeholders and decision makers. Current software suppliers (vendors) are continuing to develop their own proprietary clinical systems. These may well have the desired functionality for an individual organisation, a great user interface that attracts buyers but they are only able to share information with the same vendor system and only then if the implementation and adoption of data standards (health language) in each organisation is the same or if both systems comply with agreed HL7 messaging standards. As a consequence most of the system purchasing decisions have to date not resulted in systems achieving the most appropriate or optimum level and degree of interoperability within an organisation or nationally to meet most if not all local or national health business needs. This is well demonstrated by the continuing existence of many silos of health information not shareable by clinicians despite enormous resource investments.

Electronic Health Records and Semantic Interoperability

The business drivers identified earlier also 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. 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 continue to evolve and change. In other words the clinical knowledge domain is complex and dynamic.

Traditional system design methods require the incorporation of this knowledge to be embedded directly into proprietary application code and databases resulting in an uphill battle for such systems to accommodate frequent changes or to realise any level or degree of interoperability. As a consequence we are unable to share clinical knowledge between such systems unless we develop a data map and make a number of assumptions. We have also witnessed the deterioration and integrity of such systems over time due to changes in clinical knowledge. Consequently we are not able to confidently use the information from such systems as the basis for valid decision support systems with the possible exception of the provision of allergy and interaction alerts or reminder systems. There are two issues, 1) the difficulties associated with the sharing of clinical data from proprietary

systems and 2) the integration of guidelines with such systems as this requires the building and maintenance of many different interfaces. The latter is costly and has the potential to lead to any number of errors and compromise patient safety. Walker et al estimated that net savings of around 5% of annual healthcare expenditure could be made and concluded that the value of fully standardized interoperability is likely to be higher than their quantified results suggest. This indicates a strong business case for funding the adoption of a new national approach that has a high probability of achieving the highest degree of semantic interoperability.

A new approach to EHRs

A new approach to adopting a non-proprietary method of health system design, thus avoiding vendor lock in of data, is to adopt the Open Electronic Health Record (openEHR) two level ontology based software engineering approach. This approach requires the adoption of a set of open specifications for an EHR architecture where all clinical knowledge concepts are captured in a structured way, constraint models known as archetypes, separate from the software itself. In other words the technical system domain or technical reference (data) model on which software is based forms one level and the knowledge management clinical domain another. This results in technicians managing the technical aspects of such a system and clinicians managing the development of the clinical archetypes and templates that shape EHRs.[21] Each archetype contains a maximum data set about the clinical concept captured including supportive data required such as protocol, or method of measurement, related events and context required for accurate clinical data interpretation.

The creation of archetypes is almost purely a task for clinicians, including nurses. The process enables them to create the breadth, depth and complexity of the health record to suit their specific documentation needs. Archetypes are combined into "templates" in order to capture the data set for a specific task such as a nursing care plan. Software developers then use these to produce specific applications. The openEHR specifications are for secure, shareable health information. This provides a solid foundation on which to build interoperable, modular software applications that support distributed clinical worklow to benefits each patient journey through the health system.

Such openEHR architecture specifications are owned by the openEHR foundation, a not-for-profit company founded by the University College of London in Centre for Health Informatics and Multiprofessional Education (CHIME) and an Australian Company, Ocean Informatics who have adopted the open source philosophy my making all openEHR specifications freely available under an open licence.[22] These specifications are the result of over 15 years of research, international implementations and collaboration of an international community of people who share the vision of interoperable EHRs supporting seamless and high quality patient care. The registered online community consists of well over 1000 members from 75 countries. This openEHR approach ensures that optimum semantic interoperability between systems can be achieved resulting in the ability to also meet national health business requirements. Commercial development of this approach is occurring in Australia, UK's NHS Connecting for Health Program, the Netherlands, Belgium, Sweden, Turkey and the USA although the desired national frameworks required to fully support these initiatives have yet to be fully established.

Requirements for a national health informatics infrastructure

There are a number of fundamental requirements to enable the realisation and optimisation of semantic interoperability within the health industry as whole. Such an investment is fully justifiable on the basis of significant net cost savings to be achieved, improved patient safety and quality of care and above all for a nation to establish a sustainable national health system. This requires the development and adoption of a national technical standards framework, a national health language framework and education of the national health workforce about health informatics.

A national standards framework is where the Government, or its delegated national entity, develops or adopts a set of standards that all systems must comply with by a certain date. Such standards could be seen as providing the national health information systems configuration. It includes standards about data types, unique provider and individual identifiers, a standard information/data model (system architecture), intermediate level clinical domain models such as archetypes and a national health language standard. Its governance is about the standards development/review workplan, maintaining international liaison, making all relevant standards freely available

to all stakeholders, testing and certifying systems for compliance and promoting standards adoption which may be either voluntary or compulsory from a set date. Stakeholders are all entities that need to collect, manage the transfer or use of clinical data including software developers/suppliers, IT network maintenance personnel, departmental managers, any clinician, health statisticians, health policy developers, researchers, public health managers and others. It is within this framework that a Governments Direction, such as the national adoption of the openEHR approach, is communicated to all stakeholders. This includes a national approach to a secure health network or digital signature requirements with supporting legislation.

A national health language framework encompasses all activities associated with data standards, terminologies, classifications, labelling concepts within archetypes, standardizing these with support from relevant clinical professions. This includes the promotion for the adoption of certain terminologies such as Systematized Nomenclature for Human and Veterinary Medicine (SNOMED) Clinical Terms or classification systems such as the International Code for Diseases version 10 (ICD-10) from a certain data, management of version control, mapping data between versions, ensuring the infrastructure enables the electronic collection of data for monitoring, evaluation, research, public health management, funding, performance measurement or policy development purposes. Archetypes need to be developed in a way that ensures that all data required for these additional purposes can be extracted automatically from the EHR so that for example all discharges can be coded into the ICD-10 classification for reporting or use in casemix systems. Each nation needs its own archetype repository. Archetypes need to govern in a similar manner as classification systems and national data dictionaries are now governed to ensure that all national information needs can be met consistently over time. Such national governance and management is fundamental to achieving semantic interoperability and hence a sustainable health system. Success is achievable over time with full collaboration from all stakeholders under strong national leadership able to effectively communicate the vision.

Once such frameworks have been adopted to achieve a well communicated vision of healthcare reform, then everyone is able to develop their own transition arrangements to ensure optimum use of existing systems, enabling various degrees of interoperability to be realised thus reaping ongoing benefits. The openEHR specifications can be implemented in a number of ways to support such transitional arrangements. For example it supports personal health records, can be implemented as a message based web service, as a middleware application or to integrate existing clinical systems for the purpose of research or public health. The knowledge that the national infrastructure is being established to support that particular direction to be accomplished over a desired and feasible timeframe actively promotes this. It means all stakeholders can concentrate on working collaboratively yet all software suppliers can still be competitive with various applications as long they comply with the fundamental configuration requirements such as the openEHR specifications. Such an infrastructure may be seen as being similar to a national road infrastructure together with the adoption of road rules able to accommodate all types of cars and trucks driving from one point to anywhere else in the country in a manner that minimises the road toll. The governance of the health informatics national infrastructure needs to be managed by an entity that is one step removed from Government to maintain scientific integrity and avoid constant changes due to political influences.

This author's experience has shown that a number of critical concepts about system interoperability and its benefits in particular, appear to be poorly understood by key decision makers and others. This is a reflection on the poor acceptance and understanding of health informatics as a discipline overall. There is a tendency to promote anyone with some computing skills to an informatics position. Health informatics has a strong multidisciplinary foundation and actively supports team-oriented, technology-facilitated, informatics-supported and evidence-based health care in accordance with modern scientific principles. Consequently a strong national focus on building the workforce health informatics capacity is seen to have great potential to have a very significant and positive impact. Workforce capacity building in health informatics needs to be part of any nation's infrastructure establishment.

DISCUSSION AND CONCLUSION

This reflective paper has examined the relationships between the business drivers of Government health policies, health care providers generally and the adoption of health care information, knowledge and communication technologies for the

purpose of achieving a sustainable national health system. These technologies include the adoption of national health language and health informatics standards frameworks to ensure there is a national infrastructure that actively promotes the adoption of the best possible semantic interoperability between information systems. The various degrees and levels of interoperability have been explained together with their significance towards the ability to optimise the reliable machine processing of health data, information and knowledge including the integration of practice guidelines based on the best available evidence of good practice within electronic health records. Ideally such records are structured in accordance with the openEHR approach of two level ontology based software engineering so that all clinical data can be used confidently for decision support purposes and the best possible degree of national semantic interoperability can assured. Adoption of the openEHR approach is gathering international momentum, supported by evidence from current high profile implementations of the openEHR specifications such as in the UK NHS Connecting for Health Program.

It is imperative that key decision makers begin to appreciate the necessity of adopting strong national directions, applying strong leadership to overcome short term political and other stakeholder influences primarily based on vested interests. The focus needs to be on the public good in the first instance. We must establish and actively promote a sound business case for the adoption of a national health informatics framework that includes workforce capacity building in health informatics and supports a strategy based on the best available scientific evidence to support a sustainable health system. What is needed is a major international shakeup similar to what occurred in the transport industry many years ago when containers were adopted and every port and transport operator had to change its infrastructure and work practices to be able to handle and accommodate containers. This change created connectivity within the transport industry, it was painful for many but did result in very significant cost savings and improved efficiencies. We now need such an international change in health system connectivity.

REFERENCES

1 World Health Organization [site in the Internet]. Geneva (CH): WHO; 2008 [updated 2008; access 2007 Dez 29]. Available from: http://www.who.int/countries/bra/en/

2 World Health Organization. Statistical Information System. Geneva (CH): WHO; 2008 [access 2007 Dez 29]. Available from: http://www.who.int/whosis/en/index.html

3 World Business Council for Sustainable Development. A healthy tomorrow?: health systems, facts & trends affecting business decisions today. Geneva (CH): WBCSD [access 2007 Jan 08]. Available from: www.wbcsd.org

4 Boxer LJ. The sustainable way. Melbourne (Victoria/AU): Brolga Publishing; 2005.

5 Coiera E, Hovenga EJS. Building a sustainable health system. *IMIA: yearbook medical informatics*. 2007; 2 (1): 11-8.

6 Shanley CJ, Ellis D. A new approach to medical education, hospitals and health networks. Chicago (IL): H&HN; [access 2007 Dec 29]. Available from: http://www.hhnmag.com/hhnmag_app/jsp/printer_friendly.jsp?dcrPath=HHNMAG/Article/data/12DEC2007/071218HHN_Online_Shanley&domain=HHNMAG

7 Wellington RJ. Health IT strategies ineffective, say HealthLink: despite having created one of the world's best IT-enabled primary care systems, New Zealand's innovation has stalled [access 2007 Dec 29]. Available from: http://computerworld.co.nz/news.nsf/news/D1E146A46F11CFB5CC2573B20078F376

8 National E-Health Transition Authority [site in the Internet]. Sydney (AU): NEHTA [updated 2008; access 2008 Jan 04]. Available from: http://www.nehta.gov.au/

9 Canada Health Infoway [site in the Internet]. Toronto (ON/CA): [updated 2008; access 2008 Jan 04]. Available from: http://www.infoway-inforoute.ca/en/Home/home.aspx

10 Davidson L. eHealth insider [access 2007 Dec 29]. Available from: http://www.e-health-insider.com/news/3309/new_e-health_strategy_for_scotland

11 NHS Connecting for Health [site in the Internet]. [updated 2007 Set 09; access 2008 Jan 04]. Available from: http://www.connectingforhealth.nhs.uk/

12 eHealth Initiative's: Fourth Annual Survey of Health Information Exchange at the State, Regional and Community Levels [site in the Internet of the Annual] [access 2007 Dec 29]. Available from: http://www.ehealthinitiative.org/2007HIESurvey/

13 Atoji C. ONC Will issue updated HIT strategy in 2008 Says Friedman. Lancaster (PA): Digital Healthcare and Productivity.com; [access 2007 Dec 29]. Available from: http://www.digitalhcp.com/hitw/newsletters/2007/12/11/onc-charles-friedman/

14 World Health Organization. Resolutions and Decisions WHA58.28 Geneva (CH): WHO; 2006 [access 2007 Dec 28]. Available from: http://www.who.int/gb/ebwha/pdf_files/WHA58-REC1/

15 World Health Organisation. MIP 03 IP13 issues paper knowledge management and information technology: building the knowledgebase for health. Geneva (CH): WHO; 2003 [access 2007 Dec 29]. Available from: http://www.who.int/mip/2003/official/en/MIP_03-IP13-en.pdf

16 Information Management Strategy Committee. Australian Government Information Interoperability Framework: sharing information across boundaries. Sydney (AU): AGIMO; 2006 [access 2006 Sep 11]. Available from: http://www.agimo.gov.au/__data/assets/pdf_file/50725/Information_Interoperability_Framework.pdf

17 Walker J, Pan E, Johnston D, Adler-Milstein J, Bates DW, Middleton B. The value of health vare information exchange and interoperability. Health Affairs [on line]. 2005 Jan 19; [access 2008 Jan 2]. Available from: http://content.healthaffairs.org/cgi/content/full/hlthaff.w5.10/DC1

18 Elkin PL, Froehling D, Bauer BA, Wahner-Roedler D, Rosenbloom ST, Bailey K, et al. Aequus communis sententia: defining levels of interoperability. In: Kuhn K, Warren J, Leong TY, editors. Medinfo2007: conference proceedings. Amsterdam (NL): IOS Press; 2007. p.725.

19 Friedman TL. The world is flat: the globalised world in the twenty-first century. London (UK): Penguin Books; 2006.

20 Elkin PL, Froehling D, Baue BA, Wahner-Roedler D, Rosenbloom TS, Bailey K, et al. Aequus Communis Sententia: defining nevels of interoperability. In: Kuhn K, Warren J, Leong, TY, editors. Medinfo2007: conference proceedings. Amsterdam (NL): IOS Press; 2007. p.729

21 Leslie H. OpenEHR: the world's record, pulse +IT. Magazine [on line]. 2007 Nov 21; [access 2007 Dec 29]. Available from: http://www.pulsemagazine.com.au

22 Open Electronic Health Record [site in the Internet]. openEHR Foundation [updated 2008; access 2007 Dez 29]. Available from: http://www.openEHR.org