

2.7

Creating value from electronic health knowledge management systems: current practice in the New Zealand context

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Introduction

A good life and a good death

Currently 120 million people are born every year, born with the hope they will have a good productive life and a good, non-premature death. The role of healthcare is to try to help those newborn attain that goal. Fifty-five million people die each year. In the United States alone it is estimated that up to 100,000 die prematurely each year as a result of healthcare error. This is often cited as one of the greatest human crises in the US, being equivalent to at least 250 jumbo jets crashing each year (Institute of Medicine 2000).

However, the amount of human suffering attributable to inappropriate healthcare actions is dwarfed by that due to lack of action or no action. Of the 55 million who will die this year, 11 million will be children under five who will die from largely preventable causes (including four million babies who will not survive the first month of life) (World Health Organisation 2005). That is, at least 25,000 jumbo jets of children with premature deaths, and many more with unnecessary suffering. Even in the US, the richest country on earth, it is estimated at least 40 million people have inadequate healthcare coverage.

In the midst of these healthcare challenges, better health knowledge management systems (KMSs) aim to provide a source of equitable hope for a better life and a better death.

This chapter will report on some of the electronic health KMS developments taking place in New Zealand, a country recognised as being one of the most advanced in the world in this area. This will be set in a context of an initial discussion of what might be the core features or principles of an ideal health KMS, and how

systems may be planned and implemented to add value. It will also explore how healthcare decisions are bound by issues of time, ability, resources, costs and opportunity costs, and are characterised by varying levels from simple certainty to complex ambiguity.

A major point of emphasis will be how human health and wellbeing is firmly integrated into the health of the wider ecosystem in which we live. Similarly, it is argued that the successful implementation of electronic health KMSs requires a wider ecosystem approach, rather than just considerations of the technology. This entails exploring how electronic health KMSs can engage, empower and integrate people and their communities, and assist with the spectrum of care from individual to equitable public or population health decisions and actions.

The simple mnemonic models used throughout this chapter, were derived from the author trying to make sense and bring some order to his own experiences, reading and research in this area. Their aim is to stimulate rather than bind thought while recognising that, like all models, by trying to simplify and bring order and understanding they risk losing important complexity. The first part of the chapter will use these models to explore the concept of a health KMS. The second part will discuss New Zealand developments.

Global problems, local solutions

Information and communication technology (ICT) based health KMSs have been identified as potential catalysts for the development of effective and equitable healthcare delivery (Committee on Quality of Health Care in America 2001; Garg, et al 2005; Walker et al 2005).

However, historically and globally, the literature on implementing ICT systems that are sustainable, beneficial and valued by clinicians has been too commonly characterised by failure. Robust and stable technology is necessary but not sufficient. Healthcare is a complex system littered with the remains of visionary plans to radically transform or control it. Revolutionary or 'Big Bang' plans have often ended in a 'Big Mess'. This is typically due to a gross misunderstanding or underestimation of the degree of enmeshed complexity, and of the magnitude of the concept-reality gap or acceptance gap of what is being proposed (Orr 2000; Heeks, et al 1999; Glouberman 1996).

Good design must realistically take account of the unique developmental evolutionary nature, natural rhythms, relationships, strengths and hazards of the complex ecosystem that the implementation is planning to enhance. Failure to appreciate these factors has been central to the failure of health ICT. (Heeks et al 1999; Bryant 1998; Ash 1997; Southon 1997; Sidorov 2006).

An ideal health KMS

Discussions of the use of ICT in health typically focus on such discrete terms as an electronic patient record or clinical data repository, with an inherent focus on the actual technology or software. The concept of a health KMS explored in this chapter, aims to emphasise the importance of taking a broader, holistic, ecosystemic view. This view emphasises the desired knowledge management (KM) functions, healthcare outcomes, stakeholders, culture and empathic interfaces between sustaining enmeshed systems required in such an ecosystem (Orr & Sankaran 2007).

Core identified principles or features of such a system, that may be independent of technology, time or place, can be encapsulated in the mnemonic CARE GAPS FIRST (Figure 2.7.1).

**Figure 2.7.1:
Closing the CARE GAPS FIRST**

Clinical
Administrative
Research
Education
General Practitioners (primary and secondary care)
Allied Health Services (including secondary and tertiary care)
Patients
Supports (relationships, organisational)
Fast
Intuitive
Robust
Stable
Trustworthy

A health KMS should enhance every stakeholder's capacity or motivation to carry out the integral Clinical, Administrative, Research and Educational (CARE) functions of healthcare. The system should embrace the power of fully recognising and leveraging the whole healthcare network, engaging and empowering all the key stakeholders. These stakeholders are not just clinicians, such as General practitioners and Allied health services, but also Patients and their community of Supports (GAPS). The system must have a realistic understanding of the complex environment in which it exists and be Fast, Intuitive, Robust, Stable and Trustworthy (FIRST) within this complex environment (Orr 2004; *Standards Australia/NZ 2001; Standards Australia 2001; Sveiby 2001; Wyatt 2001; Plesk & Greenhalgh 2001; Wilson, et al 2001; Goldberger 1996*).

Health KM ecosystem

An effective, sustainable health KM ecosystem will have a number of key components. These include the innovators (or vendor company), innovation (or technology) and implementers (Figure 2.7.2).

**Figure 2.7.2:
Components of the health KM ecosystem**

Innovators	Environment
Innovation	Informaticians
Implementers	Investors
Individuals	Integrators

Many health ICT business cases recognise and provide for sufficient investment in these three components. An effective health KMS, however, also requires recognition of, and investment in, the individuals who will use the system, the infrastructure and processes

of the ‘invironment’, the investors who have to develop expertise to make value analysis, cost and opportunity cost decisions, the integrators who have to hold it all together from strategic governance to operational level and the ‘informaticians’ researching and informing through shared learning and analysis and collective development of the sector.

A sustainable ecosystem is facilitated by synergistically nurturing all its key components and relationships, and recognising and dealing with both real and perceived inequities. Some components of the ecosystem may seem insignificant but may be important for another part and hence for the whole system to survive and thrive (Orr & Day 2004).

A tale of two consumptions

Consumption has been one of the biggest killers throughout history. Today, two variants of the disease threaten to overwhelm the health and security of our communities and planet (Weizsacker, Lovins & Lovins 1998).

Consumption was the historical name for tuberculosis, and related to the deteriorating appearance of those suffering from the disease as they appeared to be consumed from inside. Better living conditions led to marked decreases in the incidence of the disease in many regions of the world. However, drug-resistant variants are currently increasingly prevalent in the poverty of the Third World, with increasing outbreaks spilling over into in the First World.

Many diseases of the First World, including obesity and type 2 diabetes, which threaten to overwhelm ‘First World’ health systems, are related to over-consumption. Over-consumption of food and resources is now leading to sick communities, a sick ecosystem and an insecure world. Uncontrolled and inefficient manufacturing and energy production can pollute our air, water and soil, and chemicals and pollutants can enter our food chain and destroy our natural capital. It can also be argued that the over-consumption of the First World contributes to the poverty and consumptive tuberculosis and insecurity of the poorer parts of the world.

Security is central to health. Sickness and insecurity in one part of the ecosystem will impact on the whole (Lovins 2002). Both forms of consumption illustrate the complex nature of disease, and how KMSs designed to improve health outcomes have to recognise the wider ecosystem that an individual and their communities exist in.

A KMS should ideally add value by enhancing the capability of an individual, organisation or community to better define and attain their strategic objectives. The typical integral domains or functions of a health service are the clinical, administrative, research and educational (CARE). Adopting a balanced scorecard type approach, the key strategic objectives of each of these domains are: Learning and growth of the individuals and systems; Improving processes both within and between these systems; attaining Financial objectives; and responding to the Expectations of customers (LIFE). Each specific system will have its own key value objectives to fill in the grid, depending on the drivers and complexities of the wider system they operate in (Figure 2.73).

Figure 2.7.3:
Adding value to CARE through LIFE

	Learning and growth	Improving processes	Financial	Expectations of customers
Clinical				
Administrative				
Research				
Education				

The concept of bounded rationality recognises the time, ability and resource issues that lead to adequate or inadequate rather than optimal decisions. In health, decisions are often bound both in their making and execution by time, ability and resource issues. Similarly, healthcare decisions are influenced by personal and community values and cognitive biases (De Martino et al. 2006; Kahneman 2003).

TAR and FEATHERS have historically been used as a way to punish or shame and mark someone out from a group. This mnemonic attempts to capture some of the boundedness and bias factors that may lead to a clinician being marked out for censure for their decisions (Figure 2.7.4).

Figure 2.7.4:
TAR and FEATHERS

Bounded	BIAS
Time	Framing (manner data presented)
	Examination (how collect and analyse data)
Ability	Anchoring (Unduly tied to a particular position, particularly the first – or primacy—position presented)
	Termination (when stop collecting data prematurely)
Resources	History (Always been or done that way)
	Expediency (Easiest answer)
	Recency (When unduly influenced by recent experience)
	Selectivity (When only consider a limited set of data items)

An adverse outcome is often not related to a bad or negligent decision-making process. In a complex environment, events will always emerge that that could not be fully controlled or predicted particularly within the bounds of the available time ability or resources.

Reviews of adverse events often provide a simple retrospective coherence that was not available to decision makers at the time, and fail to realistically recognise the boundedness of the system in which the decision was made. In a complex environment, bringing people together may help build a shared understanding of the bounded rationality and biases of the system they operate in.

Attempting to apply enough time, ability and resource to make one optimal decision for one patient may mean significant opportunity costs and 10 inadequate decisions for 10 others, and a failure to develop the next generation of health professionals.

Health KMSs need to realistically recognise and diminish the negative impact of boundedness and bias. They can add value by specifically targeting these areas, seeking to maximise the use of available time and resources and enhancing ability and minimising (or at least making overt) sources of bias.

Building a framed storyscape

When 'taking a history', although the clinician at one level is collecting facts, at another level they are building a storyscape from a series of narratives that may be presented by a patient, their family or other clinicians involved in the patient's care. Each individual involved uses their own cognitive strengths and biases to present a picture of how they perceive an issue. The 'facts' may differ depending on the source and time collected. A traditional medical note has often commenced with a restatement of the 'facts' and sources on which a particular decision was made. It provides a longitudinal history built of a series of unstructured static records. The electronic record affords a mixture of static and dynamic aspects and calls for a new style of note-taking. Electronic systems often pre-populate, decreasing the need for duplication.

Introducing structure to the electronic record facilitates the distribution and aggregation of data. However, the complex formulation aspects of a traditional medical note, where the raw data is synthesised and modelled and placed in context should not be lost; i.e. a statement of why things were perceived to be this way at this time and an indication of the boundedness and bias that influenced any decisions.

The individual or groups that interact in a health KMS will be continually pushing, pulling and producing information. The added value afforded by an expert within this system may be their capacity to synthesise and model data and place them in perspective.

Death by a thousand cuts

Clinicians have limited time. Any nonessential task that a clinician must carry out limits the time for essential tasks. Every extra piece of required documentation, or compliance or cost recovery activity, that possibly individually is considered inconsequential, cumulatively can significantly limit the time for clinical activity.

Many indirect clinical contact activities are essential to the maintenance and development of quality standards and systems. However, every activity transferred to a clinician that could have been carried out often with greater effectiveness by a different professional group, or by a clinician with less training or specialisation, decreases the amount of time and hence specialist resource that could be more effectively used elsewhere.

Medical error is associated with significant suffering and death. However, we must also consider how much nonessential or minimally productive compliance tasks decrease the time and hence the resource available for more effective decision making and clinical care provision, and thus contribute to medical error and suboptimal care of patients who are inadequately treated or not treated at all due to lack of clinician time.

Approximately 250 jumbo jets of people may be killed each year in the US through erroneous medical intervention. However, worldwide many more die through inadequate or no

intervention. Even in wealthy nations there is typically inadequate publicly funded clinical resource to meet escalating demands. Electronic systems and compliance regulations and activities may play a part in decreasing medical error. However, we must also question what part they may play in contributing to medical error and suboptimal care through inappropriate or inefficient design (Ash et al 2004; Berger & Kichak 2004).

In an electronic health KMS every second and every click counts. The system must be fast, intuitive, robust, stable and trustworthy (FIRST), and integrated into and able to cope with the natural speed, flow, complexities and ambiguities of clinical practice. Clinicians must be aware that both systems that passively connect data and people and those that provide more active levels of decision support are fallible, and they must maintain their professional vigilance and judgment at all times.

Introducing electronic systems that transfer administrative, or nonessential immediate data entry tasks to clinicians, or remove opportunities for asynchronous but more complex data entry (eg dictating more detailed notes or letters to be typed up and entered by those with greater skill and speed) is likely to negatively impact on clinician time, perceptions and acceptance.

Trust

Trust is central to health KM (Orr 2005a, 2005b). Each individual and group that interacts in a health KMS has to continually make assumptions and assessments about the level of trust they can place in others and in the underlying technology. Trust that others protect, value and respect health information and have taken due care in reporting, eliciting, analysing and synthesising information. Trust that the information will be used for the purpose it was reportedly collected for, and that ownership and intellectual capital aspects will be respected. Trust that the underlying systems are secure in terms of confidentiality, integrity and availability, and that each authenticated individual or community interacting with the system is connected with the right information, in the right context, at the right time. Trust can also vary as a function of our assumptions or assessments of individual or groups skills, or ability to report, analyse or model information, and may be influenced by prior personal relationship, rank or position and professional group. You must rely on hardware and software and the skill and professionalism of individuals' wetware.

An ideal health KMS must use a trusted evolvable language that effectively communicates what the user wants to say with a content and structure that is understandable, sharable and integratable, and that will remain so. The system must facilitate both data discrimination and aggregation for a wide range of user needs, from patients and clinicians to researchers, managers and ministers of health, providing all with both the capacity and the motivation to act.

Moving from capacity to act to motivation to act

Health KMSs aim to provide some form of positive intervention. In a clinical framework these interventions can be *universal* (for everyone), *selective* (for those with risk factors) and *indicated* (for those with signs of disease) (Mrazek & Haggerty 1994).

Interventions leading to effective change involve a much more complex process than just giving people generic information. Individuals may be at different stages of their decision-making and action-making process and may require different interventions at each stage to

facilitate their understanding, insight and motivation. Prochaska and DiClemente (1992) have identified the change stages of pre-contemplation, contemplation, preparation, action, maintenance and relapse.

We need to be increasingly cognisant of these complexities as we continue to develop health KMSs from passive data repositories for clinicians to providing more active support for the integrated range of people involved in health, including patients and their supports.

The ‘right thing’

In the US, as well as approximately 100,000 people dying from medical error, another 100,000 are killed from providing treatments that were thought to be appropriate. That is, the treatments in terms of the processes or accepted knowledge of the system the clinician was operating in were not provided in error, but their side-effects or complications killed the patient (Starfield 2000). Overall, it has been suggested that iatrogenic death or death caused by clinicians’ actions is the third biggest killer in the US health sector, with death only being the endpoint in a whole spectrum of suboptimal care. Therefore, health KMSs need to help not only in providing guidance to do the currently or locally perceived ‘right thing’, but also to help in the constant process of iterative pushing, pulling and producing of research to know, refine and update what the right thing to do is.

The ‘right thing’ to do is rarely definitive or constant. Almost all treatments have both potential benefits and side-effects requiring a process of risk-benefit analysis before being provided. Research is required to design new treatments with more benefits, fewer side-effects and that can be targeted more specifically to a specific patient’s needs. Similarly, there is an ongoing process of research required (through, for example, genetic research) to more specifically define what an individual’s needs may be and how they may be matched and respond to a specific treatment and, indeed, how they may respond if not treated.

Thinking through the wish list

A strategic planning process can result in multiple worthy objectives within the context of a shared vision. However, often the conceptual vision is not attainable in one leap and, indeed, trying to leap the concept-reality gap in one go can often result in failure. Resources, time, risk and the current capability level for change (both objective and perceived) typically lead to choices and priorities having to be made (Elrod & Tippet 2002).

As you plan to move towards the current shared vision, each potential step or building block must be assessed (within the limits of current knowledge and values) as to SAFE it is, that is, how Scalable (while retaining implementability and utility); Affordable (in terms of resource time and risk to do and not to do); Flexible (to meet individual, community, local and national needs and to cope with the vision or planned route changing); and Equitable (in that, potential stakeholders perceive that adopting the change or development will lead to a relative advantage for themselves or others).

THINKing through the wish list of potential objectives, you can Toss out (or discard as not SAFE and particularly not essential); Hold (as SAFE and essential); Incrementalise (into SAFE chunks and complete some now, some later); Negotiate an alternative for (that meets same need); Knead into a larger or different pie (and then THINK through) (Figure 2.7.5).

Figure 2.7.5:
THINK SAFE

Toss out (discard as not essential or SAFE at this stage)
Hold (essential and SAFE)
Incrementalise (into SAFE chunks, some now some later)
Negotiate alternative (that meets need)
Knead (into larger or different pie and then THINK through)
Scalable
Affordable (can you afford to do it, can you afford not to do it)
Flexible
Equitable

Planning to add value

If an electronic health KMS is to add value, there needs to be a planning process as to what that value may be and how it may best be derived.

The planning needs to occur from a strategic KM perspective of how best to meet community or organisational objectives, rather than be prematurely curtailed or influenced by a specific piece of technology.

The outcome of a planning process should not be a lifeless piece of paper (for immediate burial on the top shelf or in the bin) or an unrealistic conceptualisation, wish list or personal polemic (a shared one may be ok) but should seek to establish a shared language, understanding, significance and hope, and develop agreed parameters, principles, priorities, processes, partnerships, people and passions on which to build. The planning process can involve working through the following questions (which seek to integrate some of the themes explored in previous sections).

- What are our objectives? Where conceptually do we want to go (adding value to CARE through LIFE)? If and when reached, what would the objective look like?
- What is the reality of where we are now?
- What are the parameters, principles, priorities, processes, partnerships, people and passions (what do people really care about and want to change) that will form the basis of the plan?
- Who are our target segment(s)? What are their characteristics, needs, motivations?
- How do we position ourselves in relation to meeting those needs? What is our specific role/expertise/competitive advantage that will facilitate meeting those needs?
- How will knowledge processes of pushing (or sharing), pulling (or acquiring), producing (or creating) help us achieve objectives?
- What cultural change/changes in values, enabling technologies or organisational systems might form a foundation on which to build/sustain our plan?

- What are the natural resources, components and relationships of the ecosystem operating within that could be synergistically enhanced, leveraged and amplified? What are the hazards that could be diminished? What are the SAFE (scalable, affordable, flexible, equitable) stepping/building stones to help get from reality to concept? What are the potential stumbling blocks/traps?
- How will we cope with ambiguities; the lack of precedents or signposts for situations that might meet along the way?
- When and how will we make time to iteratively reflect on our progress and adapt our capability, future planning and goals to cope with the complex emergent opportunities, challenges and ambiguities we will face? (Winter & Smith 2006; Jafaari 2003; Fraser & Greenhalgh 2001).

Short term planning, long-term impact

In planning in a complex environment we cannot fully control or predict the future, or what disruptions or discontinuities may impact on our environment whether in the next 100, 10 or even one year. However, we must consider what consequences the increasingly short-term planning and decisions of today may have long term, to minimise the solutions of today becoming the problems of tomorrow or future generations.

We need to calibrate the response with different solutions, for different needs, for different people, at different times. One size or one style does not fit all, or cope with different or evolving conditions needs or values.

New Zealand context

Standardisation versus diversification

New Zealand has 21 District Health Boards (DHBs). The DHBs vary in regional size, population, demographic and rural/urban mix, but together they are responsible for the provision of publicly funded health and disability services for New Zealand's 4,000,000 people. The government via the collection of taxes is the primary funder of health services. The Ministry of Health sets guidelines, policies and targets. However, each DHB's individual Board of Directors decides on how they may spend their allocated funding to achieve these policies and targets within the context of the needs, strengths and priorities of their local communities. The DHBs have a focus on community engagement and empowerment and service integration. Each DHB has the capacity to develop its own unique strategies to improve the targeted health outcomes of their communities.

However, particularly as time has progressed, there have been increasing levels of iterative shared learning and 'best practice' standardisation.

New Zealand is recognised as having one of the most ICT-enabled and integrated healthcare sectors in the world (Orr 2004; Protti 2003). This enablement has been driven by an understanding that integrated KM is central to the effective delivery of healthcare and built via an iterative, evolutionary, synergistic process of diversification and standardisation.

The 21-DHB structure has led to diversified strategies informed and enabled by diversified electronic systems. However, these developments have been built on a number of centralised, standardised, enabling building blocks, including a unique patient identifier and a secure

health intranet. Similarly, the process of iterative shared learning, collaborative networks and best practice standardisation between the DHBs, in terms of strategy, has fed through to at least some level of increasing standardisation of electronic systems and associated processes.

The capacity for diversification may facilitate targeted innovation and flexibility to better meet local needs and constraints. Diversification within the complex ecosystem of health could also be perceived to facilitate resilience that is not dependent on the sustainability, or vulnerable to the actions of, one electronic system or vendor. However, standardisation also has value in terms of economies of scale and scope and the creation of a set of shared processes and language to facilitate connection and integration from the data through to the human level. New Zealand recognises the dynamic tension between diversification and standardisation and the perpetual iterative challenge of striving for the right synergistic balance.

The New Zealand WAVE (Working for Added Value via E information) strategy document (New Zealand Ministry of Health 2001) identifies some core priorities for the ongoing development of New Zealand's electronic health KMSs including the creation of agreed standards for information interchange and a centralised standardised trusted Health Practitioner Index (HPI).

New Zealand's National Health Index provides a unique identifier that can be attached to the records of a person's health events from birth to death. A person's health records can, therefore, be shared with, and integrated from, multiple different systems and locations. Trust is central to the capability of such a system. Trust that a patient has only one 'unique' identifier, (with duplicate numbers being a historical but currently decreasing significant quality control issue). Trust that such a system is secure and accessed only by authenticated users that respect, value and protect that system. The HPI aims to develop and empower that trust. It will provide unique identifier authentication of every registered health practitioner in the country. It will also facilitate the unique identification of every health transaction a patient experiences in terms of clinician, service location and organisation. Multiple different systems having multiple different identifiers for patients, clinicians and services has globally been a major barrier to effective integrated health KM.

New Zealand has taken an evolutionary developmental course rather than a revolutionary or Big Bang approach. Evolutionary, rather than strictly fixed incremental steps, in the sense that once the collective health KM ecosystem has reached certain developmental stages there has been the capability for more substantive innovative change.

There has also been a focus to date on connecting rather than correcting or controlling clinicians or changing traditional clinical processes; providing passive decision support with appropriate information from distributed sources (which they then analyse, place in context and make decisions on themselves) rather than undifferentiated active decision support trying to correct and control their every action. Passive decision support aims to help the clinician ask better questions while active decision support provides the answers from a simple suggestion to an obligatory format. There have been some excellent developments in the area of more active or patient-specific advisory decision support, particularly those targeted at chronic disease management areas such as diabetes and hypertension.

However, clinical decision making is highly influenced by complex emergent pattern recognition and widespread use of heuristics or rules of thumb. Systems that attempt to predict, control and correct every action are often perceived as having limited utility by

clinicians, as they are often too simplistically certain and linear and fail to acknowledge and integrate into their processes the complex ambiguity, multiple people with multiple uncertainties, risk-benefit analysis and boundedness that often characterises the health system. Designing systems that embrace such complexity is one of the challenges for the ongoing development of health KMSs.

The Waitemata District Health Board Clinical Information Systems Project

The Waitemata District Health Board (WDHB) is the major provider of publicly funded primary (general practitioner) and secondary (hospital and community) health and disability services to a population of over 450,000 in the west and north of the greater Auckland region. The WDHB Clinical Information Systems (CIS) project provides an increasingly typical example of 'baseline' electronic health KMS projects occurring in New Zealand District Health Boards. Such 'baseline' projects require an ongoing iterative process of nurturing and developing of the wider health KM ecosystem, if they are to thrive and contribute to the developmental capability of the system to cope with greater levels of complexity. This section will discuss some of these wider subsequent developments.

The CIS project extended from late 2002 to mid 2004. The focus of the project was to increase the capacity of a complex organisation to bring together and share key clinical information from multiple distributed sources, with the aim of providing better integrated care and better health outcomes for the DHB community. The developments intentionally built on the knowledge and experience of other local DHBs, particularly that of the South Auckland services. Using similar software and processes provided significant leverage, as well as contributing to the collective system expertise of both technical and clinical staff in the region to facilitate future developments.

Electronic system developments included:

1. A single login interface from which all key individual patient demographic information, investigation results, clinical documents and letters, and past treatment events and warnings held on the national system could be viewed.
2. Implementation of a patient tracking system for the Emergency Care Centre providing real-time information on a patient's location, investigation and treatment status.
3. Implementation of an electronic medical document repository, including the migration of 250,000 historical clinical documents.
4. Electronic clinical audit facilities, focusing initially on surgery and providing a degree of clinical outcome measures.
5. Referral status messaging and electronic discharge summaries facilitating real-time sharing of information across the regional primary/secondary spectrum.

Electronic patient management systems are the norm in New Zealand primary care or general practices. Being able to electronically manage knowledge within a hospital is an important step. However, being able to facilitate real-time electronic communication between hospitals and general practices is a significant step further towards the goal of better integrated care. Traditional paper discharge summaries are globally associated

with the problems of delays in production and delivery, and poor handwriting significantly impairing timely utility. Electronic summaries have great utility in letting a general practice almost immediately know their patient has received treatment and has been discharged.

However electronic summaries have their own content quality issues. The capacity to readily attach copious amounts of data is a double-edged sword and not infrequently occurs at the expense of focusing on modelling and synthesis of the data to explain why a diagnosis was made or treatment was started and what is required now. Indeed, this is one of the greatest ongoing quality improvement issues for electronic systems in general; that is, the importance of synthesis and modelling to extract the drops of wisdom from the sea of data.

Providing raw data was traditionally important when the proposed recipient often had no other readily available source of this data. However, access to the raw data is increasingly distributed to authenticated users throughout a region. Therefore, to add value, the structure and design of health KMSs need to focus instead on actively promoting a synthesis and modelling of the data by each user within their own context and expertise.

Although recognised as a global leader in developing and utilising healthcare ICT, there is widespread recognition in New Zealand that there is a long road to travel yet before reaching a conceptually ideal health knowledge ecosystem. Each individual, community and appropriate service must play their role in building that ecosystem. Of particular increasing importance will be the involvement of patients and their supports.

The CIS project directly impacted on over 2000 hospital and community staff and 300 general practitioners. However, the project was an initial step. Ongoing developments of the CIS project's local ecosystem have included:

- Development of a 'Knowledge Centre', that aims to provide governance and support for the creation, acquisition, sharing and application of knowledge throughout the DHB.
- Development of a regional database to provide appropriate sharing of key investigation results between primary and secondary care across the three DHBs that cover the Greater Auckland Region.
- Development of an e-library providing online access to multiple electronic textbooks and journals.
- Greater appropriate sharing of key clinical documentation, including discharge summaries across the three Auckland District Health Boards hospital or secondary care sectors.
- Creation of the Regional Privacy Advisory Group. Although the Greater Auckland Region is divided into three DHBs, there is significant movement of patients across services in the region. The Regional Privacy Advisory Group is involved in the ongoing development of a trusted partnership agreement that aims to facilitate effective care through the appropriate integration of information within a culture that respects values and protects health information.
- Development of a health KM professional ethics seminar for medical students, to help play a small part in creating the required culture.
- Creation of an interfaculty university course based on the principles of KM and aimed at developing the health KM capability of the New Zealand health delivery, academic and technology sectors.

- Development of a Senior Clinicians Group aimed at providing a 'coal face' pragmatic view of the current electronic systems' performance and priority areas for improvement and development.
- Multiple ongoing improvements and additions to the technology and associated processes, facilitating increasingly sophisticated and targeted applications.
- Creation of a National Institute of Health Innovation that brings together academics, government, healthcare and technology providers. The institute aims to promote the democratisation of health innovation, a demonstration and interoperability laboratory for the current multiple systems, and a heart and space for future collaboration and design. The aim is to develop innovative health KM and technology solutions, and associated policy and processes that facilitate equitable better health and disability outcomes both locally and globally.

Conclusion

The first part of this chapter explored the concept of a health KMS. The second part reported on related New Zealand developments. New Zealand may be considered a world leader, but on a journey where there is still a long way to go.

ICT harnesses much of its value through its capacity to leverage the collective power of networks. The leverage value of an electronic health KMS is afforded not just by connecting hospitals and GPs, but by recognising and integrating patients and their community of supports as key components of the health network.

Healthcare exists within a complex ecosystem. Technology often runs the risk of trying to reproduce a rationality that does not exist, or only exists in a bounded, biased form. Rather than trying to fully control or predict the outcomes of a complex ecosystem, an innovation or intervention should seek to integrate with and amplify the natural rhythms or components of the ecosystem that are associated with desired or positive outcomes, and decrease those associated with negative outcomes (Snowden 2005).

Healthcare involves a series of risk-benefit analyses—choices and consequences from the government policy level, to that of the individual patient's and clinician's decisions. Knowing what is safe not to do is often as important as knowing what is safe to do.

Integrated care is facilitated by the seamless connection of relevant information between appropriate stakeholders, with each stakeholder adding value through their own specific expert synthesis and modelling of the data. This specific local patient or community expertise or ability can be augmented by research-based decision support tools to help minimise the effects of boundedness and bias and maximise the effective use of the available time and resources.

The contents of a health KMS must be independent in terms of technology, time or place. It must not just last until the next major planning cycle, or the lifetime of a business or a product, but for a person's whole lifetime, and possibly for generations, while embracing and facilitating emerging new models and concepts of care.

There is a need to move from a capacity to CARE to a motivation to CARE. Central to our wellbeing is good food, water, air, sanitation, a safe environment, good sleep, activity and diet; organising ourselves as a society, that we value and feel motivated to work to attain; feeling connected to a common worthy purpose, and each other, competent and in control of our environment; nurturing and valuing our individual health and the health of our

communities, and recognising the connectedness and importance of the wider ecosystem. Ideally, a health KMS would not only facilitate the capacity to attain these core factors of wellbeing, but would also provide the motivation to attain them. Appealing to reason and self-interest with discussions of economics and quality and quantity of life is one motivational strategy. Inspiration to act is often driven by emotional responses, the creative arts, symbols, images, spirituality and a sense of community aspirational ideals and values.

There is a need to provide greater transparency for patients and their supports into the complex ambiguity that often surrounds clinical decision making. Decision making and action are often bound and influenced by issues of time, ability, resource, costs, opportunity costs and thresholds, personal and societal values and cognitive biases. People and communities can come to different decisions because they are acting under different influences and value sets and are at different stages of their decision-making process. There is a need to engage and empower individuals and their communities to assist in this constant iterative search for both knowing and doing the 'right thing'.

The development of technology is typically driven by market values and the core market value is value for money or decreased costs and increased profits. The realistic importance of the profit/loss motive, particularly in a perpetually resource-challenged health sector should not be diminished. However, it cannot be the only value. Technology increasingly moulds our world. In health, we need a broader value set of ethics and professional and collective responsibility to mould the technology. Values that will nurture health KMSs aim to provide a source of equitable hope for a better life and a better death.

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Websites on related developments

www.stjohn.org.nz/products/lifelink.aspx (alert bracelets)
www.enigma.co.nz (risk prediction and chronic disease management)
www.orion.co.nz (health knowledge management software)
www.physiome.org.nz/ (imaging of body)
www.digitalearth.org.nz/ (Earth imaging and information systems)
www.nzhis.govt.nz/ (national databases and warning systems)
www.sismex.co.nz (clinical investigation/data storage and management)
www.ctr.u.auckland.ac.nz/research/stomp/# (stopping smoking with mobile phones trial)
www.smartinhaler.com (online asthma management)

Appendix 1: Body of knowledge

This appendix outlines a scenario for the integrated use of electronic health KMSs in the very near future. Although individual products have not been identified variants of almost all the component systems are already in use in New Zealand or at least at some stage of conceptual development.

Picture this scenario. You collapse in your home. The wristband communication device you are wearing contains a physiological sensor that picks up changes in your heart rate and breathing. You fail to respond to a prearranged signal.

The device calls an emergency medicine ambulance service, and provides both your location and your unique health identifier. It also calls your next of kin with a prearranged alert message. The device is also linked to your monitored alarm system, which detects break in, fire and medical alerts.

They phone your home. There is no response so they also send a guard, to both check you have not been physically attacked and assist with gaining access to your home. The ambulance triage service using your unique identifier call up your health records including recent contacts, diagnoses, investigations and medication. They note you have a history of heart disease, high blood pressure, high cholesterol, asthma and diabetes, and have recently visited your family doctor reporting an increase in frequency and intensity of your angina chest pain. Your GP has already made a specialist referral and your appointment was due for next week.

The triage officer decides that your history warrants sending the specialist cardiac ambulance that includes a doctor who specialises in cardiac resuscitation. The ambulance GPS system guides them in the most effective way to your home. En route, the doctor can continue to peruse your records including your last digital chest x-ray and the last ECG tracing of your heart.

He can see your home blood glucose monitoring results for your diabetes that have been transmitted directly to your record. He can also see exactly how much you have been taking of your asthma inhalers including your home peak flow monitoring of your lung function, all the details of which have already been transmitted electronically to your record. You have a healing ulcer on your left leg for which the district nurse has been visiting you.

The doctor can flick through the digital images that the district nurse has been taking of the ulcer and see it appears to be slowly healing with no gross signs of infection on the image or nursing report. The doctor notes that you previously successfully gave up smoking using a text message-based motivational system.

You also experienced some significant depression and anxiety in the past, which your GP used an electronic decision support system to help him diagnose and manage and you were helped by a combination of online and automated phone spoken message based cognitive behavioural therapy. The doctor also notes that due to the nature and severity of your various illnesses you have been enrolled in the electronic chronic disease management program.

This system proactively continually updates your risk profile and recommends the latest evidence based treatment, and coordinates all the tasks surrounding your care including contacts and investigations. The national alert system shows a severe allergy to penicillin, and the district nurse has recorded in the local warning system you have a large dog that barks a lot and can be frightening.

The ambulance crew can also call up an integrated health geo-information system providing satellite images, three-dimensional representations and floor-plan images of your home. The system also provides data on local air, water and soil quality. The ambulance crew and doctor readily gain access to your home and find you collapsed in your living room. The guard takes care of your dog. You are unconscious but breathing, and have a weak pulse.

An ECG confirms a myocardial infarction (heart attack) treatment is commenced based on the latest evidence-based guidelines and you are transferred to hospital. As you enter the emergency care centre you are given an armband that allows your movements to be tracked at all times throughout the hospital. Your (and all your fellow patients') locations in the emergency department and your triage details, are represented on an electronic white board. All your information and investigations are available electronically to the clinical staff. All tasks required for your care can be ordered and coordinated electronically.

Your doctor is informed electronically when your investigations are returned. All x-rays are now in digital form. There is an abnormality on the chest x-ray that the emergency care doctor is not quite sure about. There is a significant shortage of radiologists in your area, so your health board has come to an arrangement with a hospital 12 time zones away to provide cross cover and, therefore, each service only needs radiologists providing local cover from 8 am to 8 pm. It's now 9 pm so the emergency doctor sends the x-ray image electronically and receives a report back almost instantaneously along with a message to call the radiologist. The radiologist talks to you on the phone while being able to demonstrate on your local screen the features of the image that have led to his opinion.

As you are transferred from the emergency care centre to the cardiology ward, where you have also been referred electronically, an episode of care summary is sent directly to your family doctor's electronic patient management system. While on the ward your medications are checked for interactions by an electronic system and each dose dispensed individually and administered to you only after it has been electronically prompted and checked with your armband. You make a good recovery; your medication is optimised according to the latest evidence-based guidelines, your prescription is transferred electronically ready to be picked up at the pharmacy. When you pick up your medication an electronic record is also made of that.

The doctors are aware from repeated research that patients being non-adherent or only intermittently adherent with prescribed medication is very common. If you don't pick up your medication that is a signal to the doctor to explore possible reasons and try to find an agreed plan for moving forward. The pharmacist's co-payment claim is also transmitted electronically to the appropriate government agency.

You are commenced on a cardiac rehabilitation program. There is a range of people involved in your care including doctors, specialist nurses, a dietician and a physiotherapist, and they have even provided you with a 'green' prescription to attend your local gym. The rehabilitation team is using the latest 3D computer-generated graphics of the body to help with their education and motivation. You have finally managed to give up the cigarettes but you remain clinically obese, have a poor diet and have a significant history of alcohol abuse.

The computer graphics system can illustrate everything from a DNA and cellular level up to whole organs and the functioning body. A full 3D functional image can be created of yourself from your physiological and risk factor data with even your face superimposed,

and can be moved back and forward in time to show how your body has and may progress in terms of your risk factors to date. They can demonstrate everything from how your cells and, ultimately, tissues and organs and bodily appearance and function change.

They can show your heart beating, lungs breathing your limbs and face moving, your blood flowing and your eyes, liver and kidneys functioning, or progressively not functioning as in your case. They can show what you might have looked and functioned like if you had lived better and avoided the toxins, and also how you will likely progress in the future if you do or don't control your risk factors and optimise your treatment. The 3D software can also be switched into clinical teaching mode, where the doctors using equipment fitted with special sensors can practice procedures—from putting a drain in your lungs to taking out your liver or heart. On a lighter note, the software can tell you exactly what size and style of clothes you should wear and can show you at different weights, and can even provide you with the optimal fit for a new tennis racket or golf clubs.

All these demonstrations are stored in your medical record, which you can also access and add to from home. You can also be connected with other people who may have similar conditions to provide mutual support through your recovery process, and relevant support agencies and resources.

Your daughter-in-law took your new grandchild to the family doctor today for his immunisations. These are all managed through the national system. The family doctor notes that your daughter-in-law phoned his service out of hours about another child having a sore ear and was connected through to the triage nurse. The triage nurse had 10 years emergency department experience, but was currently home working so she could look after her own child. From her home the triage nurse could access all the family doctor's files and through a series of computer-generated, guided questions provide initial advice to callers with a full computerised report being sent back to the family.

On further discussion your daughter-in-law advises the doctor that she has actually been worried the child might have a long-term problem with her hearing. The family doctor arranges an appointment electronically with the local hearing clinic and discusses advances in both electronic hearing testing and devices. The family doctor was also able to talk to your daughter-in-law about her latest cervical screening test, and discuss whether she wished to be entered relatively early into the breast screening program due to a high risk family history.

Your daughter-in-law has read a lot about bird flu and asks the family doctor whether there is anything she should do. He provides some general advice and tells her the government is setting up a National Pandemic Database to help with any outbreak. He also mentions that the city council have just purchased an electronic disaster planning and crisis management system to help deal with everything from major earthquakes to disease outbreak.

He also notes that electronic kiosks have been set up in all the major shopping centres to provide key community health information, particularly for those without personal access to the internet.

All the clinical interventions are recorded and managed using electronic systems, as are the co-payment requests that are sent to the government.

All the data can be de-identified and aggregated to assist with administrative, research and educational purposes, and a dynamic health picture built up through 'geocodes' of a large region, or a local area.