SmartPaths – Capturing Context Rich Data across the Health Care System to Inform Quality, Outcome and Cost

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Aim

To improve clinical care and outcomes by following best practice guidance and improving transparency to inform quality outcome and to quantify the health costs of variation.

Objectives

To demonstrate how SNOMED CT as the core ontology within a technology stack can produce rapidly developed clinical pathways that capture patient information as individuals flow through the health system. The context rich data captured, along the pathway, informs planners and funders on health system variation, the quality of care and provides more accurate estimation of variation related costs.

> "Studies from 4 benchmark leaders demonstrate that implementing a multifunctional IT system can yield real benefits in terms of increased delivery of care based on guidelines , enhanced monitoring and surveillance activities, reduction of medication errors, and decreased rates of utilization for potentially redundant or inappropriate care."
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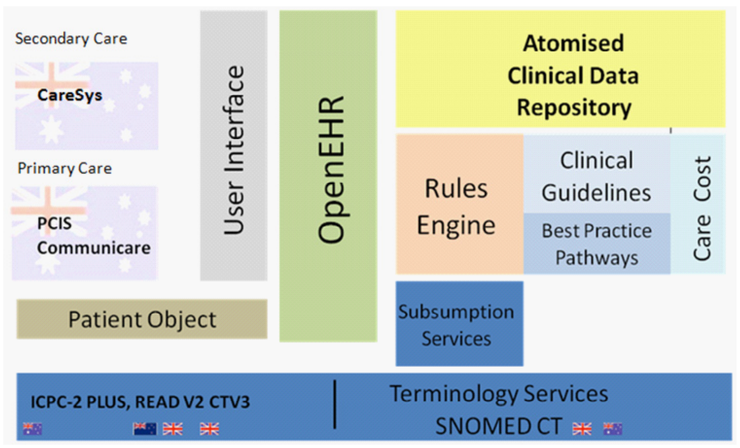
> Systematic Review: Impact of Health Information Technology on Quality, Efficiency, and Costs of Medical Care Annals of Internal Medicine Basit Chaudhry, MD *et al.* 16 May 2006, Vol 144, No. 10

Figure 1. High Level iCareNet System architecture supporting Smart Paths



Clinical Context

Australia's Northern Territory presents a number of challenges to clinicians in the provision of health care, both with its geography and the challenges of distance. There are also indigenous health cultural differences. This is further complicated by significant workforce shortages with high levels of staff turnover and limited access to specialist services. In the Territory, the health service delivery model has evolved to rely heavily on onsite nursing staff and Aboriginal Health Workers with high levels of 'virtual' medical support by telephone, video and retrieval services.

Within Aboriginal communities there is a very high burden of disease and the age of onset for many of these conditions is much younger than the rest of Australia. In addition there is a high prevalence of multiple co-morbid disease which has contributed significantly to the disparity in life expectancy between aboriginal and non-aboriginal Australians.

Within the Remote Health sector, PCIS and Communicare are the predominant primary clinical information systems (CIS) used to create plans of care in the delivery of health services to clients across community health centres. These clinical systems use internal care planning functionality, but are not supported by evidence based decision support, nor have any capacity to share these plans of care and their associated data between community health clinics in different locations. Further, any information held in these systems is also inaccessible to the acute care sector or Secondary Care clinicians who are providing the virtual support from a distance.

iCareNet is a cloud based software portal and provides a centralised system for clinician's to use as a tool to analyse a patient's clinical data applying evidence-based best practice guidance via a clinical decision support inference engine.

The system allows clinicians to use this guidance to build electronic Plans of Care (SmartPaths) customised to a client's individual clinical requirements as an output.

Every patient in iCareNet therefore has a Smart Path customised to their own specific clinical needs. This plan of care is the best practice care package and forms the basis of their ongoing clinical management, supporting the patient journey through the continuum of care.

SNOMED unifies disparate systems

iCareNet extracts clinical information from PCIS and Communicare Clinical Information Systems (CIS) both these systems use ICPC-2 PLUS coding systems. ICPC-2 PLUS coding system is a primary care based coding system for understanding primary care encounters, processes of care and symptoms and problems. ICPC-2 PLUS is mapped to SNOMED to drive the clinical rules for the Smart Paths.

The patient object layer communicates with the different CISs and provides the unifying step to the OpenEHR data model. An example of the OpenEHR DCM is presented in figure 2. The ICPC-2 PLUS codes are translated by the terminology service to SNOMED CT by one to one maps. An example of this is illustrated in Table 1, below.

Table 1. Terminology Service translating ICPC-2 PLUS codes to SNOMED CT

Episode example: 23 yr old woman with first pregnancy

Notes Structure	Description	ICPC-2	Term Description	ICPC-2 Plus	Term Description
RFE	10 week pregnant lady presents vomiting and concerned her baby is at risk.	W05 W27	Pregnancy vomiting/ nausea Fear complications of pregnancy	W05001 W27003	Morning sickness; pregnant Fear (of); complications pregnancy
Findings	Dry mouth and heart rate increased with loss of skin turgor	W31 T11	Pregnancy Medical Examination/Health Evaluation Partial Dehydration	T11001 W31010	Antenatal care Dehydration
Diagnosis	Hyperemesis gravidarum	W05	Pregnancy vomiting/ nausea	W05004	Hyperemesis gravidarum
Process	Referred to obstetrician for rehydration and antiemetic medication	W66	Pregnancy Referral to physician/ Specialist / Clinic/Hospital	W67002	Referral; obstetrician

Notes Structure	ConceptID	Term
RFE	51885006	Morning sickness (finding)
	102915009	Nosophobia (finding)
Findings	424525001	Antenatal care (regime/therapy)
	34095006	Dehydration
Diagnosis	14094001	Hyperemesis gravidarum
Process	183548001	Referral to obstetrics service (procedure)

The OpenEHR data model is then passed to the rules engine which generates the appropriate baseline plan of care and the associated additional care plans based on the patient's pre-existing morbidity. The rules engine identifies the co-morbidities through the subsumption of the SNOMED CT conceptIDs. The additional requirements from the care plans are then retrieved from the best practice pathways this informs the system on scheduling, medication, referrals, laboratory requests and imaging, Figure 2. The guidance for iCareNet is based on the Woman's Business Manual version 5.

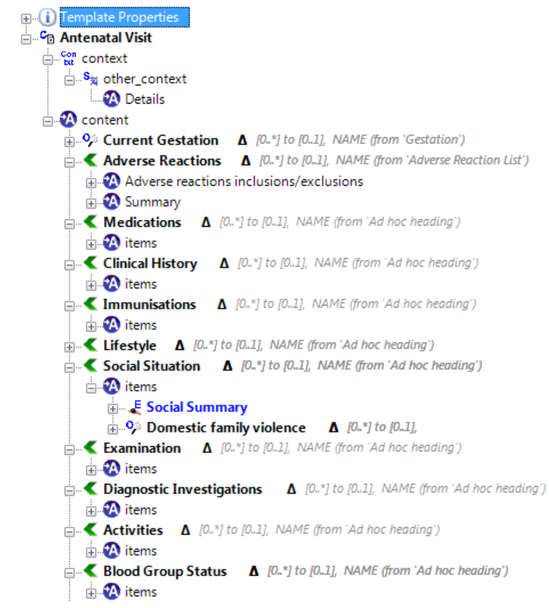


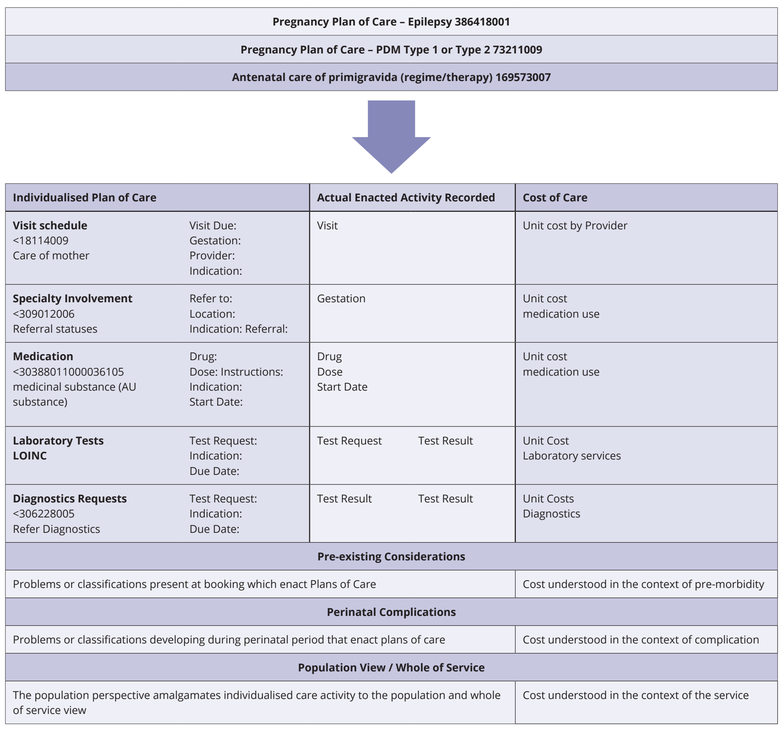
Figure 2 The OpenEHR Detailed Clinical Data Model

Care plan building

Antenatal baseline plans of care are applied to the individual based on gravida status and ethnicity. The baseline plans represent the proposed care for an uncomplicated 40 week antenatal episode of care. Additional plans of care identified by the SNOMED CT subsumption service, morbidity, are layered on top of the baseline plan to build an individualised best practice care plan. An example of an epilepsy plan of care is illustrated in Table 2. This provides the system with an understanding of the care to be enacted for individual patients. As the patient progresses during the pregnancy and through the healthcare system the platform captures activity data from the user interface and the data is stored within the atomised data repository.

Therefore the best practice plan of care for every individual can be directly compared to the enacted plan of care to provide an understanding of variation from the best practice guidance, Figure 3.

Figure 3 Plans of Care: Layer on top to deal with multi-morbidity



With the additional of cost information associated with individual components of care as illustrated in Figure 3, the variation from the best practice path can therefore be quantified from a cost perspective. Complications arising during the pregnancy are also recorded and additional plans layered. All the information and plans are stored within the data repository the additional healthcare activity related to the complications is also understood and quantified in terms of cost.

Table 2 Best Practice Plans of Care Pathways.

Pregnancy Plan of Care – Epilepsy (386418001)														
Task	**Detailed Clinical Model DCM**	**Current Archetype**	**When Diagnosed**	**1st Antenatal Booking**	**12**	**18**	**24**	**28**	**32**	**34**	**36**	**38**	**40**	**41**	**42**
Red Cell Folate	Antenatal Care plan – Pathology 1st Request	✓	✓	✓											
Therapeutic drug levels	Antenatal Care plan – Pathology Test Request	✓	✓	✓											
Folate 5mg a day	Antenatal Care plan – Medication Instruction	✓	✓												
Refer Neurologist	Antenatal Care plan – Referral request	✓	✓	✓											
Refer Obstetrician	**Antenatal Care plan – Referral request**	✓	✓	✓											
vitamin K oral Konakion 20mg	Antenatal Care plan – Medication Instruction										✓	✓	✓	✓	✓
Book delivery at hospital Transfer to regional town for birth	Antenatal Care plan – Referral											✓			

Smart Path care plans

The tiered architectural design provides separation of the guidance within the Smart Path care plans from all the other components within the system. Smart Path care plans are held within the rules engine and additional plans can be added and the complexity of morbidity supported. Conflicting recommendations are dealt with in a hierarchical prioritisation table. The Smart Path system allows the system to expand and cover more clinical scenarios without any additional programming.

The architectural design is clinical specialty independent and allows for the embedding of the technology stack into any health care scenario not just antenatal care.

In conclusion.

We describe the iCareNet system based on the BPAC CS technology stack. The technology supports the delivery of best practice guidance to Aboriginal antenatal care in Northern Territory. The technology supports complex decision making for a mobile transitory work force and population. SNOMED CT facilitates standardisation of meaning and consistency of patient data across disparate patient information record. It is the core ontology that enables the rules engine to drive clinical decision support.