A Unified Model to Support an Information Intensive Health Care Environment

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Abstract. The two parts of this paper respectively analyses the mismatch between current systems and practice in health care, and present an outline design for enhanced Integrated Care Pathways (ICP) knowledge and information management based upon mature ICT technologies.

1. The Mismatch Between Systems and Practice

Central to healthcare is the patient. The next most important group comprises the information management advocates for patients and their relatives, i.e., the nursing team.

Registered nurses (RN) must spend three years or more in full-time education to gain the required knowledge which fits them for practice. Where further education and training have taken place, nurses become advanced practitioners with increased knowledge, skills and expertise. Why then are RNs treated as novices and offered mechanised systems of paper based processes that are flawed from the outset?

The main role of nursing is that of communicator. Nurses act as the information advocate for patients and communicate patient care to other nurses, medical and allied staff. Nurses must be given opportunity to assume self-identity, as Gidden states [5]: “A person with a reasonably stable sense of self-identity has a feeling of biographical continuity which she is able to grasp reflexively and, to a greater degree, communicate to other people.” What is needed are Information Systems (ISs) that recognise registered (expert/master) nursing knowledge and freely permits communication for the benefit of patient care. “Information shared and communicated to other health care professionals will allow new views and relationships to evolve where multiprofessional care and patient involvement will become increasingly commonplace, leading to better patient care.” [1]

In reality, delivery of care by RNs is the conscious design of interventions, based upon often unconscious assessment and matching of nursing, medical and societal knowledge. In observation, RNs plan prospectively but often record care retrospectively. These interventions can be nursing activities, but could be used by all those interacting with the patient. Medical diagnosis, if known, activates evidence set(s) which are defaults associated with the interventions. If the medical diagnosis is unknown, recorded interventions retain validity and so we envisage a computer link to a “problem base”. Evidence as defaults recognises the importance of supporting activity and for adding to the body of evidence supporting practice. Opportunity must be present to highlight additions specific to the patient, also adding to the body of knowledge that is evidence based practice. There is a knowledge need for seamless inclusion of information to and from the general practitioner (GP) in the case of secondary (or tertiary) care. In community care, there is a knowledge need for inclusion of secondary care information to the GPs. We therefore envisage a non-segmented IS in which the RN enters the interventions, the medical practitioner enters the medical diagnosis and the computer system links the two “knowledge bases” (Figure 1). Interventions and medical diagnosis are linked through an IS. Problem(s) can then be identified from stored knowledge, thus adding the final dimension to the building of evidence based practice. Outcomes are developed from changes to interventions and medical diagnostic record.

Through recording interventions, the ‘active’ part of the system, clinical coding, workload data, skill-mix and costing information can be generated from everyday activities. Medical diagnosis can provide a link between direct medical input and a structure of coding
classification without need for administrative secondary input. Nursing can act as the
generator of patient information without detriment to care, through reduced administrative
data collection. Responsibility for practice is maintained through unique identity and
password use of the system by the multidisciplinary team. Care progression can be
monitored from recording when care has been given. Management can view activity levels
of service provision, and interlinkage with support services, such as transport, meal
provision can be directed from the interventions. Printouts can be selected to fit need, for
example, if one RN is handing over to another RN the intervention printout may be
selected. If an RN is supervising a student, the full process-orientated record may be
requested, showing problem(s), evidence set(s), intervention(s) and outcome(s). If a
multidisciplinary case conference occurs, then all progression information can be included.

Students of nursing (or other disciplines) have available to them, through mirrored
educational computerised systems, actual practice records giving them not only information
on interventions set against outcomes for quality of care determination, but also a live data
set of healthcare today. It is envisaged that such information access will reduce the theory-
practice gap significantly and ensure that nurses and other healthcare professionals are
prepared to understand their identity in the health care society and improve the activity of
patient care. “...the promise of the information age has not been realized in health-care
because of the technical short-sightedness of closed systems and socio-political boundaries
that inhibit collaboration and data sharing.” [2]

2. An Infrastructure for Enhanced ICP Knowledge and Information Management

Preliminary IS modelling of the use of ICP knowledge within primary health care (Figure 2) was motivated,
in particular, by our desire to seek an infrastructure in which the triangulation in Figure 1 can be supported.
Our aim was therefore to abstract out intrinsic processes and information, from aspects which are simply a
consequence of the systems currently in operation and which cause the current mismatch between systems
and practice.

Figure 2. depicts abstract repositories for: knowledge about “best practice” treatment, in
the form of ICPs; operational data about treatment of patients, including prescribed ICPs,
interventions and outcomes; and historical experience that (potentially) exists in the form
accumulated and aggregated operational data. The information flow is an idealised feed
back loop. Healthcare knowledge on which treatment is based is constantly updated on the
basis of historical knowledge about treatments, interventions and outcomes. “Best practice”
knowledge (ICP knowledge base) is applied to prescribe appropriate care for patient
conditions, in the form of ICPs; data about patients’ conditions, prescribed treatment, care
interventions and outcomes are recorded (ICP Patient database) during ICP administered;
and the feedback loop is completed by collecting together patient data (ICP data
warehouse) and inferring new “best practice” knowledge from evidence provided by the
patient data.

![Figure 1: Intervention-based care delivery](image-url)
This model suggests use of established ICTs (Figure 3). Relational databases can be used to implement “ICP Patient Database”. “ICP Data Warehouse” can be implemented as a data warehouse, using data mining techniques to derive new knowledge based on treatments, interventions and outcomes which diverge from the expected norm. “ICP Knowledge base” can be implemented using relational database technology, as collections of facts and constraints about hypothetical patients and treatments. There is also potential for artificial intelligence solutions, such as deductive databases, for automated reasoning relating to diagnosis, prognosis and prescription. An intranet can provide communications infrastructure necessary for seamless integration of the system across healthcare and professional boundaries, for example, through point-of-care data capture and access. The servers, ICP-KB, ICP-DB and ICP-DWH, respectively manage the knowledge base, database and data warehouse components in Figure 2. The client applications maintain and utilise information and knowledge represented in these repositories. ICP-KBA and ICP-Consultant respectively supports administration of knowledge in ICP-KB and retrieval, into ICP-KB, of ICPs for specific patient conditions. ICP-Manager supports administering IPCs (in ICP-DB) and capture of data generated. ICP-Miner implements data warehousing and mining functions to maintain ICP-DWH and derive evidence-based IPC knowledge.

We also note that modelling patients and treatments is a special case of the general problem of modelling histories of artefacts. We therefore propose using the GENREG data model [4] for representing ICP data. GENREG is a temporal model developed and implemented using relational database technology at the National Museum of Denmark to represent historic and administrative information about the museum's artefacts. GENREG can represent ICP information as graphs in which nodes represent patient data, and edges are labelled with descriptions of events that associate them (Figure 4). This simple representation of information as data is surprisingly powerful and expressive, since artefacts may be connected by multiple edges, each labelled with the same or different events. This feature can be used to represent and access patient or care
information in all of the contexts within which it occurs, for example, to record alternative diagnoses and prognoses or to evaluate alternative treatment pathways. This representation also supports manipulating and combining pathways, for example, for treatment of multiple conditions.

The data structure depicted represents a step in the progress of an ICP. The white boxes (artefacts) represent details of the patient before and after treatment. The shaded box (event) represents the intervening treatment event, prescribed by the ICP.

Figure 4: GENREG representation of Patient Data

To the best of our knowledge, no one has yet looked at supporting what actually happens in the clinical setting. Projects to transcribe structures which have worked in other areas to the health care domain have largely failed. The majority of work in the field has been in the USA. Only small systems are currently available in the UK, which may help to design and analyse variances from paper-based ICPs. None currently allow recording of progress on the ICP, though HBOC are writing a system (MRPC module of DMNWSE) to do this.

3. Conclusions

In the UK, the White Paper, “The New NHS: Modern and Dependable” [3] has set many challenges and introduced and developed concepts which will affect how the health service functions. Two main themes can be linked to this paper: modernising information management and technology and its use within healthcare; and the establishment and delivery of proven clinically effective care. “Information for Health” [6] clearly focuses on delivering information to healthcare professionals to support day to day clinical practices. Co-ordinated patient care is one of the primary objectives of the strategy. Also, technological support of care delivery is needed to provide access to evidence bases in order for clinicians to update their knowledge and skills; thus facilitating the provision of clinically effective care. Delivery of effective care is monitored closely by the department of health in the form of clinical governance, which places responsibility of quality and safe practice not just onto chief executives, but onto all members of staff.

We have identified a current weakness in healthcare systems, i.e., conflict with practice. An IS modelling approach revealed an information feedback loop and associated repositories and processes which are fundamental to administration of healthcare. We have proposed a technological infrastructure, which implements this model using proven ICTs. This system can reduce conflict with practice and advance exchange of knowledge.

Future work is to develop and validate the propose system in healthcare situations.

References