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THE SUITABILITY OF CARE PATHWAYS FOR INTEGRATING PROCESSES AND INFORMATION SYSTEMS IN HEALTHCARE

Abstract

Purpose: This paper examines the suitability of current care pathway modelling techniques for supporting business improvement and the development of information systems. This is in the light of current UK government policies advocating the use of care pathways as part of the £12.4 billion programme for IT and as a key strategy to reducing waiting times.

Approach: We conducted a qualitative analysis of the variety in purpose, syntax and semantics in a selection of existing care pathways.

Findings: Care pathways are typically modelled in an ad-hoc manner with little reference to formal syntax or semantics.

Research limits The research reviews a small selection of existing pathways. The feature set used for evaluation could be further refined. Future research should examine the suitability of applying existing process modelling techniques to care pathways and explore the motivations for modelling care pathways in an ad-hoc manner.

Practical implications: The development of care pathways can aid process improvement and the integration of information systems. However, while syntax and semantics are not standardised the impact of care pathways in the work of Department of Health agencies, in particular Connecting for Health, is likely to be limited.

Value: The results provide insight into the limitations of the state of the art in care pathway models. This highlights a significant omission in the Department of Health's approach and identifies an important direction for further development

that will aid Connecting for Health, healthcare organisations and healthcare professionals to deliver more effective services.

Keywords: Care pathway, process modelling, healthcare, clinical information systems, National Health Service, Connecting for Health.

Paper type: Research paper

1 INTRODUCTION

In developed economies the process of providing healthcare is complex. The 57 million citizens of the UK are provided healthcare "free at the point of use" by the government-owned National Health Service (NHS), which employs 1.3 million staff, making it the largest employer in Europe (NHS, 2007b). The organisation is significantly devolved to regional authorities and local semi-autonomous trusts with complex mechanisms of regulation and funding. In addition to this organisational complexity, healthcare itself is inherently complex. A healthcare professional's decision about whether to intervene in a patient's care, and if so how, is not necessarily clear-cut. In many cases patients require individualised care, have needs which change rapidly and often present with a number of problems, the treatment of which will impact upon each other.

To assist health practitioners in providing the best possible care a large and growing body of guidance has been produced. Both organisations and individual workers need to become aware of, select, absorb, interpret and implement appropriate guidance from this resource locally and for individual patients. The collation, review and 'just in time' dissemination of this resource presents a significant challenge. Of increasing importance in the dissemination of guidelines is the development of "care pathways" to describe the good practice journey of a patient through a department or an episode of care. Care pathways are used locally to direct and plan activity within hospitals and nationally as part of clinical guidance. For example, many emergency departments in the UK have large numbers of short pathways displayed as posters to guide care in situations such as chest pain or suspected drug overdose (S. Clamp, personal communication, May 11, 2007).

1.1 The development and use of Care pathways for managing processes in healthcare

Care pathway is a broad term used within healthcare to describe sequences of healthcare provision provided to patients with particular care requirements or through particular parts of the health service (National Library for Health, 2005). Similar terms are occasionally used but in all cases the metaphor is of a journey from the patient's perspective with an emphasis on their needs. Care pathways can be used to mean the care received within one department, but are increasingly being used to signify the complete package of care related to a particular episode. Typically a patient presents with particular symptoms, certain assessments are carried out, the patient is treated accordingly and on recovery the patient is discharged. A care pathway is a model of the anticipated activities for a set of related scenarios. The model is usually presented as either a diagram or a form containing activities and decisions.

Traditionally the notes of consultants and doctors have been held separately from those of nursing staff. Campbell *et al.* (1998) define an integrated care pathway as a structured document where all expected observations and interventions during an episode of care are listed and the results of activities recorded in one place. This helps to standardise care around good practice and assists communication within the care team. This pathway concept also provides flexibility and aids an analysis of variance from routine care because differences from a routine approach are recorded. In this way a care pathway encourages examination of alternative practices and can lead to itself being modified (Coiera, 2003). Campbell *et al.* (1998) recommend a method for generating the information that makes up the necessary contents of an integrated care pathway. However, they provide no pro-forma or recommendations for laying out the document. They argue that an integrated care pathway could help a patient take ownership of their care if shared with them and suggest that introducing electronic care pathways would aid analysis of the information captured.

An investigation of the effectiveness of two care pathways (de Luc, 2000) found there were several significant changes in clinical measures and patient satisfaction, mostly involving the support and information they received. Staff comments for both pathways were positive and stated that they directed their attention to clinical care and potential improvements. However, strong concern was

noted over the quality of the pathway documentation, cost of development and ownership of the pathway. An influential Cochrane Review of care pathways for stroke suggested there was little evidence of positive effects from these pathways and even some possibility that they were resulting in decreased quality of life and independence for the patients (Kwan & Sandercock, 2004). However, a review of pathway trials in the literature by Bandolier Extra (2003) found almost all the pathways examined provided better quality care at lower costs. There is acceptance within the medical community that pathways will be useful tools for some, but not all conditions (Martin, 2006).

1.2 The role of care pathways in information systems development and performance improvement strategies

NHS Connecting for Health is the agency in charge of the biggest non-military ICT project in the world (NHS, 2007a), a massive investment (£12.4 billion) in clinical information systems that will support care directly (NHS Connecting for Health, 2007). It must also assist continuity and information sharing across organisational boundaries. *Information for Health* (Department of Health, 1998) was a precursor to this investment and recognised that integrated care pathways were an important aspect of information systems that will support clinical activity. *Information for Health* also identified that analysis of relevant information harvested from local and national care pathways could enable a continual quality improvement programme. The British Computer Society's report on Connecting for Health (British Computer Society, 2006) criticised the absence of a standard for care pathway representation and urged its creation.

Care pathways are increasingly being used as an instrument of government policy. In 2004 the UK Government announced that "by 2008, no one will have to wait longer than 18 weeks from GP referral to hospital treatment" (Department of Health, 2004, p. 27). The deadline for this target has now been clarified as the end of 2008 (NHS 18 Weeks Team, 2008). The implementation document *Tackling hospital waiting: the 18 week patient pathway* (Department of Health, 2006) placed an emphasis on "thinking in and measuring whole pathways" (p. 10), as opposed to focusing on the work of individual departments. It is intended that adoption of care pathways will allow large sections of a patient's journey to be booked in advance, rather than the patient moving from one appointment to the

next. Care pathways should also help with the redesign of the service so that more activities can occur during one appointment.

Unfortunately there appears to be little cooperation between Connecting for Health and the 18 weeks implementation team despite their interdependencies. Even though the importance of care pathways is recognised there is strong anecdotal evidence that suggests their formulation, dissemination and interpretation rarely follows formal techniques (Derry, 2007). The importance of combining information systems development with process improvement has been well discussed (Davenport, 1993; Hammer & Champy, 1993). Briefly, information systems can support different processes than were previously possible through, for example, coordinating and integrating technologies (Curtis *et al.*, 1992). Furthermore, the use of information systems is inherently interwoven with an organisation's process (Swan *et al.*, 1999).

A classic definition of a business process is a "set of partially ordered activities intended to reach a goal" (Hammer & Champy, 1993). A business process model can be considered a representation of a class of business process instances (Kueng & Kawalek, 1997). Combining these definitions we argue that a care pathway is a type of business process model as it is a description of the typical sequence of activities involved in caring for a patient with particular needs (the goal).

Within the information systems and software engineering literature there has been extensive work developing techniques, languages and methodologies for modelling business processes (Aguilar-Savén, 2004) including Soft Systems Methodology (see Checkland, 1999), the Business Process Modelling Notation (see Object Management Group, 2008), the Unified Modelling Language (UML) (see Booch *et al*., 2005; Object Management Group, 2007), use case modelling (see Cockburn, 2000; Jacobson *et al.*, 1995) and goal-oriented modelling (see Dardenne *et al.*, 1993; Yu, 1993). This paper does not examine these techniques but recognises that they provide ample opportunities to formalise care pathway models.

This paper investigates the state of the art in care pathways within UK healthcare and uses a qualitative analysis of a selection of care pathways to examine their readiness for the introduction of new information systems promised in *Information for Health.*

2 RESEARCH METHOD

The preceding review has established that care pathways are recognised as important tools in the design and delivery of information systems and that they have been demonstrated to be useful for improving the quality of care. It has also been established that standardisation is considered important for their use in information systems, both by the British Computer Society with specific reference to care pathways and by the information systems and software engineering community through their endeavours to develop formal languages for process modelling in general. The research therefore seeks to assess whether current care pathways lack standardisation.

The research method is a qualitative analysis of a selection of care pathways. The selection of care pathways for study was not random. Rather, the pathways were selected from the medical and health literature as being examples of good practice. The examples presented here are therefore considered informative of the current state of the art in care pathway development. The care pathways vary in formality, presentation, intended audience, and use and it is this variety that we aim to explore.

Material on each case study was drawn from the NHS literature and the sample domain examined. We looked at both the graphical representation of the pathways and the supporting advice. Based upon an initial examination of the pathways, the authors constructed a feature set to assist in comparison by identifying markers of some of the important aspects of process models: purpose, strength of syntax and clarity of semantics. The selected pathways were then evaluated by the authors and a comparison of their features was developed. A selection of international care pathways was then evaluated using the same feature set. The two groups' evaluations were then compared to allow for comment on the reliability of the approach.

The research method was chosen to efficiently highlight the lack of standardisation that we believe exists in the majority of care pathways. The purpose was not a comprehensive review but instead an illustration of the gap between current practice and the required standardisation to successfully deliver on the policy of electronic care pathways.

3 SELECTION AND FEATURE SET

3.1 British care pathways

As described above, good examples of care pathways were selected and a feature set constructed as follows. Five care pathways from five different sources were selected for investigation:

- Cervical torticollis treatment care pathway developed by Map of Medicine (2006)
- Medical genetics care pathway developed by NHS Connecting for Health (Temple & Westwood, 2006)
- Acute adult mental health care pathway developed by Lincolnshire Partnership NHS Trust (2004)
- Spinal Cord Compression care pathway developed by Velindre NHS Trust (Pease et al., 2004)
- Haematuria Care Pathway developed by the 18 Weeks implementation team (Laitner & Normanton, 2007)

3.2 Feature set

As a result of a first review of these care pathways a feature set was developed. This is presented here with an explanation of each item.

- The intended audience

  This is important for the choice of presentation. Different audiences are interested in different features and therefore the pragmatic quality of a model will require different semantic and syntactic ability and quality.

- The medium of delivery

  This affects how it is disseminated, updated and used in practice. Some pathways are used to capture individual patient events. Only electronic care pathways can provide hyperlinks to supporting evidence and additional information regarding the pathway. Electronic care pathways may also be integrated in the clinical information system. The two mediums identified were electronic (indicating some degree of navigability) and paper (which includes static documents in PDF format) and therefore a criterion of *electronic medium* is used in the comparison table.

- Use to capture individual pathways

The use of a pathway as part of an individual's care will clearly need to provide space for recording the observations and interventions involved. It should also contain useful prompts regarding the future actions required to deliver care effectively.

- Degree of formalism

  Differing degrees of syntactic and semantic formalism offer contrasting virtues and disadvantages. Highly formal approaches result in explicit models but may introduce great complexity. They can be used to create detailed models that cover all of the exceptional circumstances which can be anticipated. The consistent use of a formal technique also makes comparisons between models possible. More relaxed approaches can offer flexibility, ease of creation and understanding. These approaches also allow for a greater degree of individual interpretation which brings with it ambiguity. The influence on pragmatic quality is therefore dependent on the importance of these aspects to an intended use. The following items will be used as indicators of formality: *clear start point*, *clear activity sequencing*, *distinction between parallel and selective branches of activity*, *clear presentation of decisions* and *internal consistency*.

3.3 International care pathways

The international pathways selected for comparison include two Australian pathways, a Canadian pathway, a European pathway and a US pathway. The pathways are:

- Tobacco use cessation care pathway for dental practice presented at the 1st European workshop on tobacco prevention and cessation for oral health professionals (Ramseier *et al.*, 2006).
- Type 2 diabetes care pathway developed by Queensland Health (2008) in partnership with General Practice Queensland as an online version of an existing poster.
- Stroke care pathway for use as part of the patient's health record developed by Calgary Regional Health Authority (2001).

- Heart failure in adults care pathway published by the Institute for Clinical Systems Improvement (2007), a Minnesota based collaborative comprising health plans and medical groups.
- Hearing services care pathway to illustrate the new way in which patients are to be treated as part of the Australian Government hearing services program (Australian Government Department of Health and Ageing, 2008).

4 CURRENT CARE PATHWAYS

This section discusses the British care pathways that are being examined to give a background of their ownership, intended use and the features which are particular to them. The pathways are then examined against the criteria set out in the preceding section.

The first pathway is a cervical torticollis management care pathway developed by Map of Medicine (2006). This is a national pathway which is claimed to be a "best practice… clinical benchmark" (Map of Medicine, 2007). Map of Medicine is a series of interconnected boxes containing concepts, events and activities with associated information. The connections and text within Map of Medicine are not built upon any formal syntax, for example it does not indicate the difference between decisions and parallel actions or when activities should happen. The care pathway is designed to be used by health professionals and can be localised by organisations. Despite being electronically accessible Map of Medicine does not enable the details of a particular case to be recorded within it. This means that variance from the pathway cannot be recorded and so they cannot verify that their pathway is best practice. It also means decision support activities based upon statistical analysis of patient data (e.g. diagnostic support) must be handled outside Map of Medicine. This inability to handle case data and the lack of a formal model means that attempts to reformulate good practice based on localisations will not be directly supported by the tool.

The second care pathway examined is a medical genetics care pathway developed by a Connecting for Health 'Do Once and Share' project (Temple & Westwood, 2006). The projects were intended to

gather knowledge on particular specialities, part of which involved the formulation of a generic national pathway. In each case the pathways were aired at a series of meetings to produce an agreed document.

The authors of this pathway have apparently attempted to use a formal notation and include several icons (although no key). However, the technique chosen has reached its limitations of expressivity when confronted with a three way choice which states 'Select action 1 and/or 2 and/or 3'. This fails to inform us of why we might choose these actions or what they are. There is a mix of concepts, objects, decision results and actions in the one box type while decisions are singled out (as a diamond) and three items are in a dashed-edge box without explanation. The arrows also appear to mean different things are 'flowing' (process, patient, information, samples etc.), but what or when is never stated.

An integrated care pathway to manage the full journey through a mental health hospital for adults admitted as acute in-patients (Lincolnshire Partnership NHS Trust, 2004) is examined next. The pathway was developed in the hospital and is to be used with the patient to assess their needs and agree appropriate treatment. It is presented as a form unlike the other pathways described here and is quite typical of many of the documents in the National Library for Health (http://www.library.nhs.uk/pathways). It is the only one to provide space for recording an individual patient's observations and interventions. The complete document is thirty pages long with an overview and keys. The document contains a number of tools for assessing patients and provides space to record their chosen treatments and any variance.

The fourth care pathway is for cancer patients with suspected spinal cord compression and was developed and implemented by physiotherapists and medics at Velindre NHS Trust (Pease et al., 2004). The flow chart is attached to patient notes and annotated as actions are carried out. However, no specific areas for the annotations are provided. Supporting the flow chart is a set of guidelines to explain and elaborate upon the diagram. The implementation of the care pathway resulted in a significant reduction in complications and a significant increase in patient survival.

The final care pathway developed by the 18 Weeks implementation team is for haematuria (Laitner & Normanton, 2007). This pathway was developed from a template designed for the commissioning of care pathways to achieve the 18 Weeks target. The 18 Weeks care pathways have been formulated in conjunction with clinical experts nominated by the Royal Colleges (NHS, 2008). The pathway template starts with patient symptoms and lists the diagnostics and treatments appropriate in primary, specialist and sub-specialist care (this particular pathway does not include sub-specialist care) and reasons for referring between the groups. This choice of layout was designed to help reduce the amount of care that is performed in specialist and sub-specialist settings. This pathway appears to suggest that the only 'treatments' that can be offered by the specialists are 'Watchful Waiting' and 'Reassurance Information Self-help'. It seems unlikely a specialist would be restricted to such activities since the pathway states that primary care can provide antibiotics. It is also unclear what the 'Watchful Waiting' would be for. The form only provides space to identify one set of medication, one invasive treatment, one psychological treatment etc. Unless a symptom always results in one group of treatments, this layout will force serious errors into the model.

4.1 Comparison of care pathways

Table 1 provides a comparison of the features of the care pathways examined for cross-reference. These comparisons are discussed in detail below.

	Cervical torticollis	Genetics	Mental health	Spinal cord compression	Haematuria
Intended audience(s)	Clinician	IS developer	Clinician	Clinician	Commissioner
Use to capture individual pathways	✗	✗	✓	✓	✗
Electronic medium	✓	✗	✗	✗	✗
Clear start point	✓	✗	✓	✓	✓
Clear task sequencing	✓	✗	✓	✓	✓
Distinction between parallel and selective branches	✗	✗	✗	✓	✗
Clear presentation of decisions	✗	✓	✓	✓	✗
Internally consistent	✓	✗	✓	✓	✓

Table 1. Comparison of British care pathway features

The care pathways for mental health acute admission, cervical torticollis treatment and spinal cord compression are all designed to be used directly by clinicians for patient care. Two other intended audiences are identified: IS developers and commissioners. Of the pathways developed for clinical use, only the mental health pathway provides specific space for capturing the details, although it is possible to annotate printed copies of the spinal cord compression pathway. The cervical torticollis pathway cannot be annotated as it is electronic and does not provide for this. None of the pathways investigated have direct links to an underlying clinical information system.

A variety of styles have been used for the dissemination of care pathways. The Map of Medicine and 18 Weeks commissioning pathways have each developed their own standardised format. In contrast 'Do Once and Share' teams did not receive training or instruction to use any particular style of

representation for the care pathways they formulated. The spinal cord compression and mental health pathways were initially designed to be used locally and have not been developed using a formal syntax; however, they have now been disseminated retaining their original design.

None of the pathways examined have an explicit start point, but in four an assumption can be made that we start with the top item (this was considered a clear start point). However, the clinical genetics pathway has three apparent start points with no guidance as to why one should be used in preference to another or if all are to be used concurrently. All of the graphical pathways use arrows to illustrate task sequencing while the mental health pathway uses ordering, numbering and statements such as "Activity completed within 3 hours by Admitting Nurse" (Lincolnshire Partnership NHS Trust, 2004). However, task sequencing is not clear in the clinical genetics pathway due to the lack of clarity over start points, the mix of activities and artefacts and the use of double ended arrows. Only the spinal cord compression pathway makes a distinction between parallel and selective branches by using the traditional diamond symbol to represent a decision and labelling the following arrows appropriately. The clinical genetics pathway does attempt to use a decision diamond but the supporting material appears to suggest that parallel branches may also be selectively traversed making the choice unclear. The clinical genetics care pathway also lacks internal consistency because there is no arrow head on the line between the 'synthesis' box and 'Finished clinical genetics episode of care'.

	Tobacco use cessation	Type 2 diabetes	Stroke	Heart failure in adults	Hearing services
Intended audience(s)	Clinician	Clinician	Clinician	Clinician, Provider organisation	Provider organisation, Clinician
Use to capture individual pathways	✗	✗	✓	✗	✗
Electronic medium	✗	✓	✗	✗	✗
Clear start point	✓	✓	✓	✓	✓
Clear task sequencing	✗	✗	✓	✓	✗
Distinction between parallel and selective branches	✓	✓	✗	✓	✗
Clear presentation of decisions	✓	✓	✓	✓	✗
Internally consistent	✗	✗	✓	✓	✓

Table 2. Comparison of international care pathway features

A comparison between the international pathways again shows wide variety in features. All of the care pathways have a clear start point and all are intended for clinicians, but with these exceptions there is no other feature that they all share. The extent of the disparity between these pathways appears similar to that found between the British examples. In each comparison, reading the tables vertically there is one pathway which exhibits three features and one which exhibits four. In table 1 there is one care pathway which exhibits five features and one which exhibits six, while in table 2 there are two care pathways which exhibit five features. This leaves one pathway in each table: in the British table the genetics care pathway has one feature, while among the international examples the hearing services pathway has two features. Reading horizontally, the similarities between the tables are less clear. Each table has one pathway in an electronic medium and all but one of the ten

pathways have a clear start point. However, while only one of the British care pathways has a distinction between parallel and selective branches this feature is found in three of the international care pathways. Conversely, four British care pathways have clear task sequencing but just two international care pathways do.

The key finding from both selections of pathways is that there is a wide variety of documents which describe themselves as pathways both nationally and internationally. These documents have a limited degree of structure to them, many use flow chart styles and some use a number of icons to make indications. However, the rigour of their syntax and semantic quality is questionable. This may be pragmatic given the purpose of each document.

5 DISCUSSION

The results presented here demonstrate that care pathways continue to be developed with insufficient consideration of syntactic and semantic quality. The massive investment in healthcare ICTs will best be able to deliver timely and relevant information to clinicians, managers, commissioners and policy makers if integrated with care pathways. This evidence suggests that this goal, first outlined a decade ago in *Information for Health* (Department of Health, 1998), is a long way from being realised. Whilst the British Computer Society rightly identified the failure of Connecting for Health to develop or adopt a standard for care pathways (2006), the present research identifies current practice as largely informal and we therefore postulate it will be difficult to adapt to any future standard. Unless there is a committed drive towards standardisation and formalisation of care pathways then the scale of benefits accruing from the new information systems will only have limited success.

In the light of this evidence we ask what features a care pathway standard would require to be fit for purpose. Recker has proposed a framework for understanding process model quality (2007) that we consider to be informative, which considers three levels: syntax, semantics and pragmatics.

The syntax is the formal laws or grammar of a modelling language and defines how its symbols or parts may be joined together correctly. Recker proposes that the importance of syntactic quality is dependent on purpose; while formality is vital for workflow enactment it may be a disadvantage for

models describing business processes where understanding may be hampered by rigour. This provides an interesting problem for care pathway standardisation because if a standard is to enable a link between care pathways and electronic health records as well as guiding a clinician's actions it must be rigorous and yet easy to follow. To counter this it may be useful to have a simple presentation that derives from the formal model which can sit in the background unnoticed by the end-user. This would allow for the advantages of formalisation and retain an ease of understanding.

Semantic quality relates to the fit between the meaning of a model and the reality it represents. A recent paper has investigated the ability of clinical computer interpretable guideline languages to represent a range of generic control-flow patterns with the top performer managing 22 of 43 patterns (Mulyar *et al.*, 2007). As Recker notes, the importance of each of these patterns depends on whether the domain needs them to be represented.

The pragmatic quality of a process model is its ability to assist its users as they desire. As we have seen care pathways are developed for many purposes including guiding individual clinicians' work, improving communication between clinicians, understanding patient flows for commissioning and to inform the development of clinical information systems. Therefore, a wide range of perspectives need to be considered in any future standard.

There is a plethora of existing tools for process modelling in general (Aguilar-Savén, 2004; King & Johnson, 2006) that could potentially be adopted or adapted to manage the care processes in the NHS. There are also a number of purpose built languages for clinical guidelines (see Peleg *et al.*, 2003). However, this research demonstrates that these approaches are not being widely used even when care pathway development is being directed by government agencies. This suggests that while only the concept of pathways and not a specific standard are part of government policy then a formal language will not be adopted by the agencies, companies, clinicians and managers developing them. This in turn means that new techniques for representing pathways are being created ad-hoc, absorbing effort that may be better placed in the model itself.

6 CONCLUSION

This paper has assessed the current practice of care pathway development and identified that it is non-uniform and often improvises a scheme of representation. For local care pathways to be effectively integrated with regionally or nationally procured information systems, the use of strong standards for care pathway models will be required. However, standards currently exist for process modelling and clinical guideline modelling, yet this alone has not led to their widespread adoption among the creators of care pathways. With respect to government agencies such as Connecting for Health this could be remedied with the adoption or adaptation of an existing language. For the many clinicians or improvement teams that operate at a distance from the Department of Health any decision to adopt a standard would require them to be aware of its existence and to perceive a benefit. The integration of locally managed care pathways in clinical information systems may provide some of that impetus. This invites future research in two related streams: defining a good standard for care pathways and identifying what is hampering adoption of existing standards. Through this work formal representation of processes may become the norm within the NHS. As a result, the dramatic improvements in health care services envisioned in the 18 Weeks initiative may be achieved and supported by integrated clinical information systems.

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