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A Model Driven Approach to Care Planning Systems for Consumer Engagement in Chronic Disease Management

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Abstract

This work demonstrates a model-driven approach to the development of care plan systems, amenable to: (a) a flexible and extensible definition of care plan scope; and (b) deployment of care plan viewing and tracking functionality to a wide range of physical computing devices. The approach utilises a care plan domain model from which guideline implementers formulate care plan templates aligning to specific clinical guidelines. A clinical end user would subsequently constrain that template (e.g., selecting a subset of available activities and specific targets) to create a care plan instance for an individual patient. An XML care plan visualisation definition created using the Marama tool is transformed to OpenLaszlo script from which Shockwave Flash objects can be compiled, creating Flash applications that run on a variety of hardware for both clinical and patient users. The approach is illustrated with respect to an overweight and obesity guideline.

Introduction:

There is obvious potential for benefit from the provision of electronic support for chronic disease management. Warren et al. (2001) demonstrated that the intent of chronic disease management guidelines could be accurately modelled in a decision support tool for care planning. More recently, in New Zealand, the PREDICT CVD/Diabetes tool for cardiovascular risk assessment and management is now widely deployed and is contributing to improved documentation and understanding of cardiovascular disease risk factors (Riddell et al., 2007; Wells et al., 2007).

E.H. Wagner's Chronic Care Model envisages 'productive interactions' between an informed, activated patient and a prepared, proactive practice team (Improving Chronic Illness Care, 2008). Such a model mandates the engagement of both the health provider and the health consumer in creation, monitoring and maintenance of a shared care plan. Successful systems have emerged for components of the Wagner process: e.g., (a) the Ferret system has been installed in more than 50 community clinics in Queensland, predominantly in the northern areas, to provide electronic care plans and chronic disease management support for a range of common chronic conditions (McDermott et al., 2007); and (b) the STOMP system has demonstrated significant improvement in smoking cessation via a txt messaging based dialog direct to consumers (Bramley et al. 2005). With the emerging success of individual systems, the question is how to achieve more general platforms to support dissemination and tracking of individually tailored care plans, and how to encompass both healthcare providers and health consumers in the scope of a single software solution.

Methods:

We have developed a domain model for care plans where care plans consist of performance measures (e.g., BMI), activities (e.g., jogging, or taking a specific medication) and, recursively, of sub-care plans. Activities have supporting attributes, notably schedules and instructions. A domain-specific language (DSL) has been created using the Marama tool suit (Liu, 2007) allowing a visual editor and production of XML definitions. Figure 1 provides a simplified representation of the care plan domain model.

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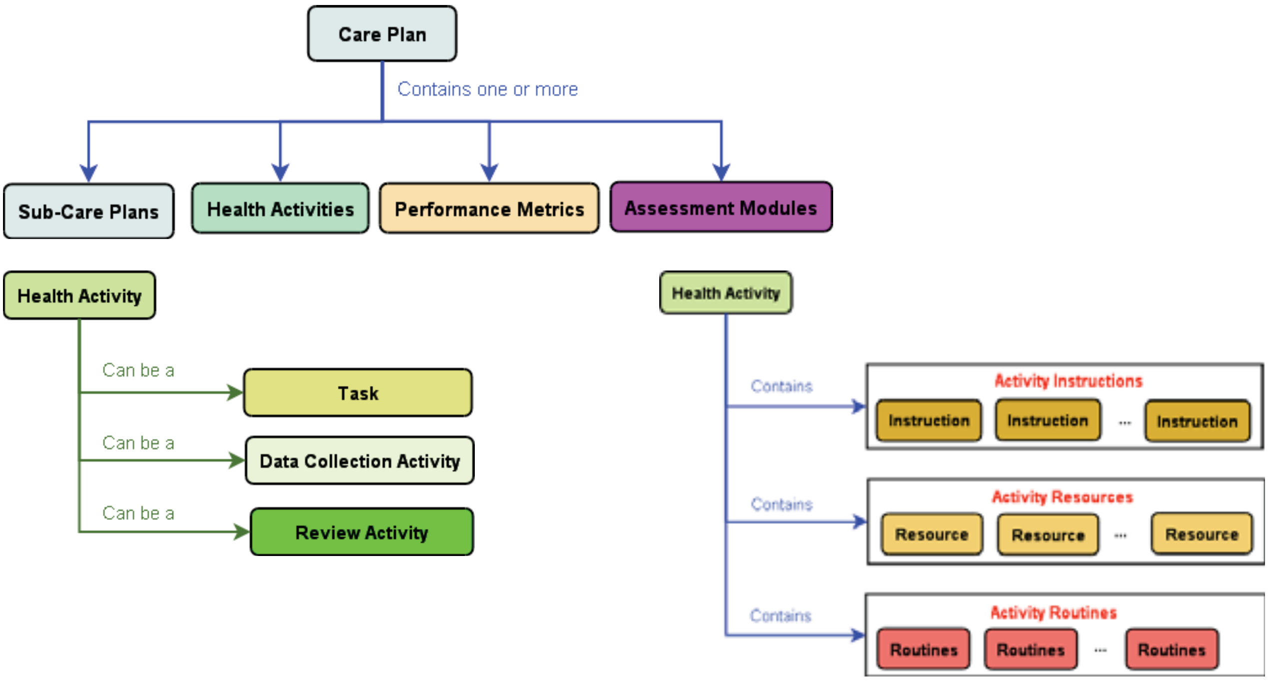

Figure 1. *Key aspects of the care plan domain model*

Our model of care planning calls for a two-stage application of the care plan DSL: (1) at a knowledge engineering stage, a care plan template is created to suit the requirements of an evidence-based clinical practice guideline; (2) subsequently, when a template is applied to a patient, the model can be edited to tailor the care plan for instantiation (e.g., to include individualized instructions). At this second stage a specific timeframe for the duration of the care plan and its review schedule would be introduced.

A second modelling tool permits the instantiated, but still abstract, care plan to be mapped to a suitable graphical user interface. This step allows for the wide variation in form factors of mobile devices that the plan could be deployed to for patient use. The resulting concrete care plan may then be downloaded to the patient's preferred device (PDA, phone, etc) and executed using a generic Flash or DHTML based interpreter (we have used OpenLaszlo [Laszlo Systems, 2007] to develop this). We examine use of this approach to care plans on a conventional PC system for a GP tailoring and reviewing a care plan; and for reviewing and logging notes to adhere to specific activities on a smart phone device for a patient.

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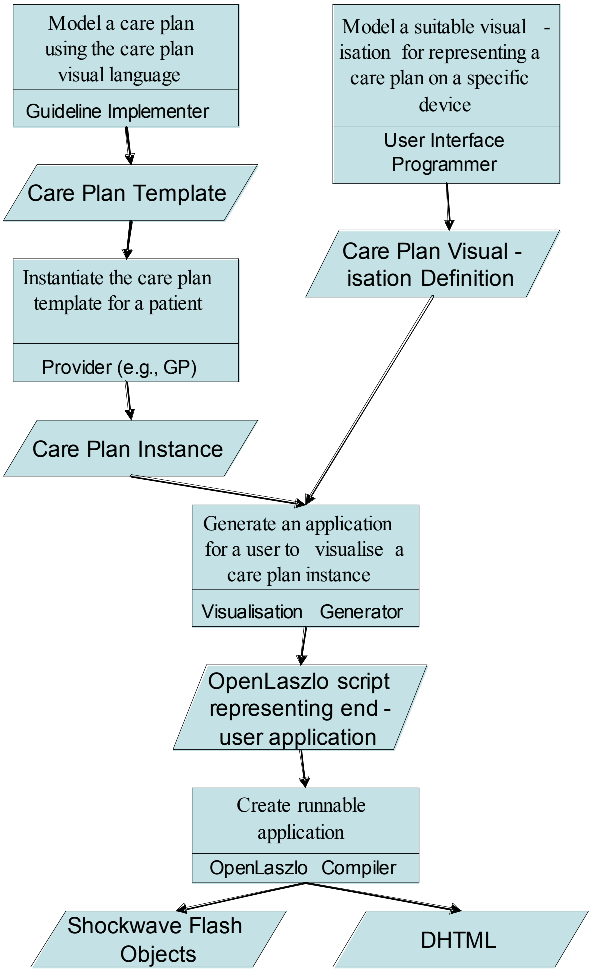

Figure 2. *Depicts the care plan development and implementation process*

Results:

To illustrate the care plan modelling, tailoring and user interface implementation approach we use a US National Heart Lung and Blood Institute guideline for managing overweight and obese adults (National Heart Lung and Blood Institute, 1998) as the source for formulating a care plan template. Figure 3 provides a simplified illustration for some of the care plan template components for the overweight and obesity guideline based on our care plan domain model.

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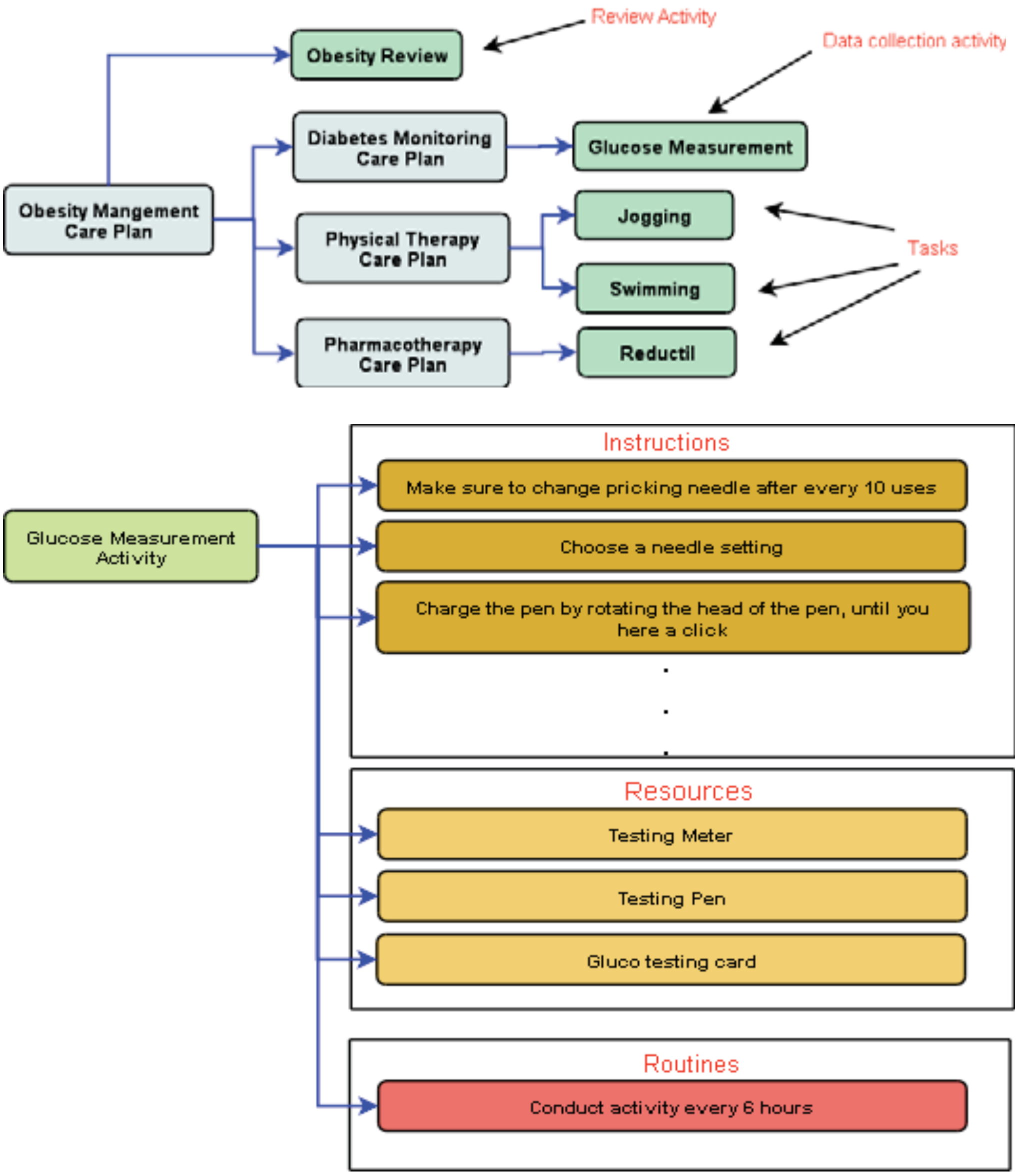

Figure 3. *Some of the care plan template components for a care plan based on an overweight and obesity guideline (National Heart Lung and Blood Institute, 1998).*

To create applications based on the guideline requires care plan visualisation definitions to be created. Figure 4 shows part of a diabetes care plan model specification. The result of this specification is a generic care plan definition, which can be tailored for a particular patient and then transformed to OpenLaszlo script which can then be compiled to an end user application. Figure 5 shows screen shots of a care plan instantiation screen as might be used by a care coordinator on a desktop PC; and a sequence of screens that might be viewed by a patient entering a blood glucose measurement on a mobile phone or PDA.

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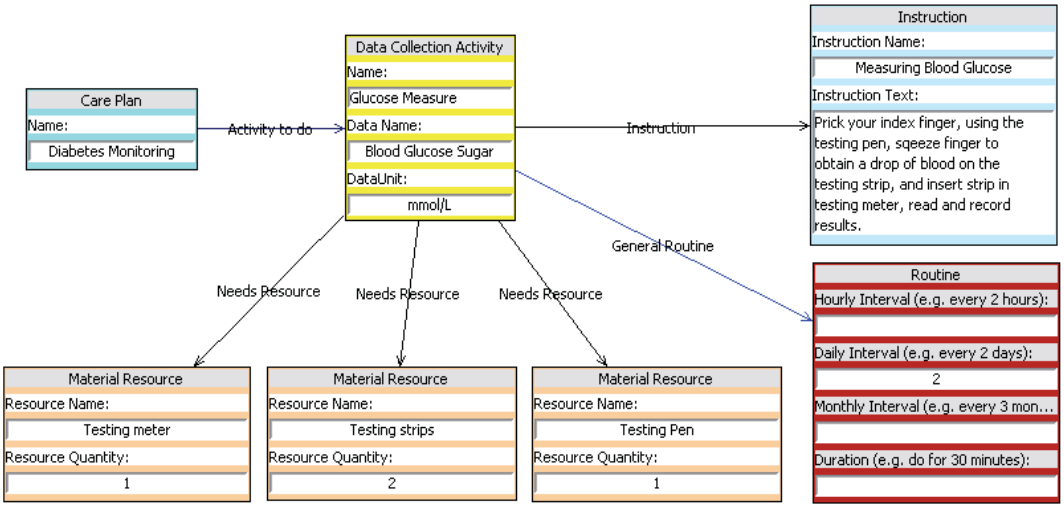

Figure 4. *Screen shot of part of a diabetes monitoring care plan: a data collection activity for the collection of blood glucose sugar measurements*

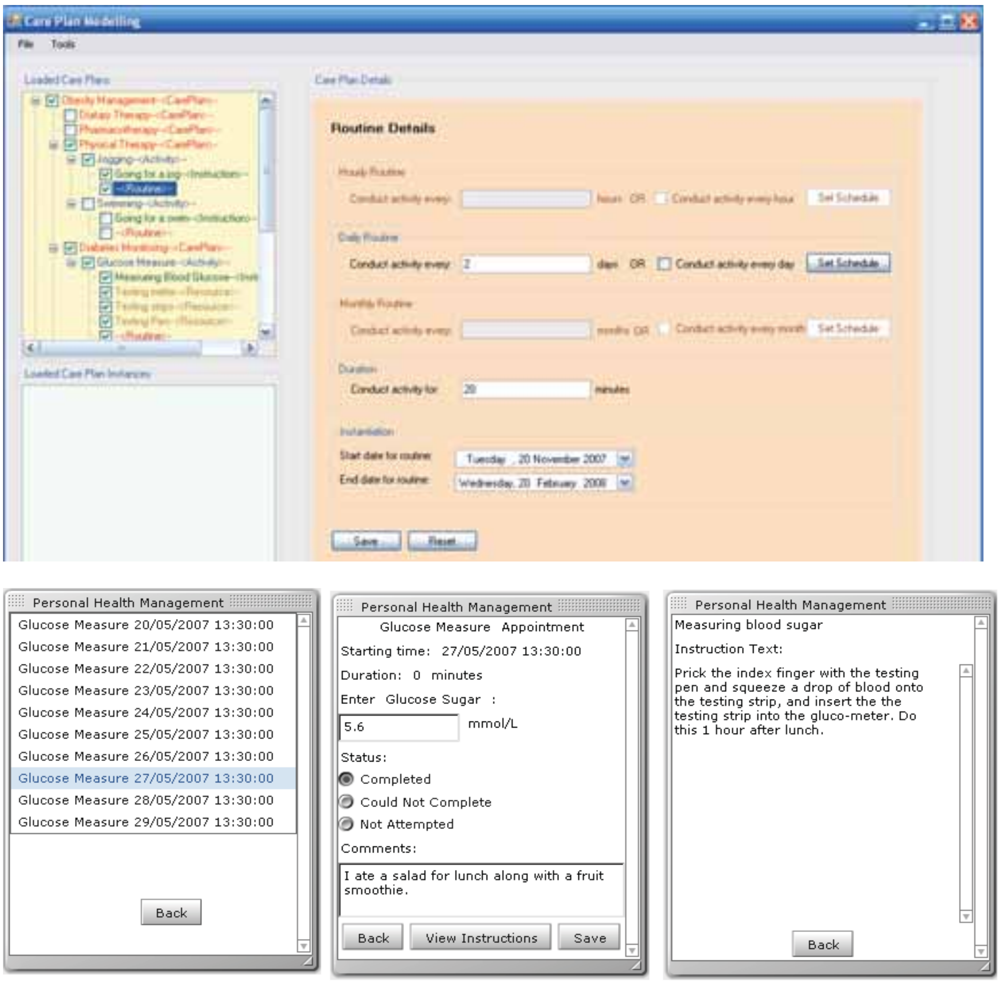

Figure 5. *Screen shots of the care plan instantiation application (top) and end-user Flash application (bottom) compiled from OpenLaszlo*

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Discussion:

We have described a staged meta-modelling approach to development of care planning systems. This approach allows a growing library of care plan templates to be mapped to a broad range of devices. This in turn supports the distribution of care plans between providers and patients, and the opportunistic use of desktop or mobile devices, with ready extension to new devices as they emerge.

There are in fact a large range of technology options for the key stages of our architecture (including Microsoft technologies). The specific languages and editors of our solution are just one possibility for achieving a model-driven approach to care plans; however, we contend that any approach should have similar stages.

Use of this approach in a healthcare system as found in New Zealand or Australia would require integration with existing software infrastructure, notably the practice management systems employed by General Practitioners (GPs). It is likely that GPs would favour care plan template selection and tailoring using their familiar tools, requiring compatible components to be implemented in the popular commercial software (or for that software to embed the care plan components). Further user testing is required for both healthcare provider and health consumer users, and it must be recognised that model generated user interfaces may lack the flair of purpose-built screens.

An important direction for this sort of work is to achieve alignment with key international standards. Of most relevance would be establishment of correspondence of the individual care plan template concepts to SNOMED CT. Success of Hrabak et al (2007) in mapping automated guideline components to SNOMED is promising in this regard. Also relevant is the alignment of the care plan in a larger sense to HL7, both in terms of alignment of the domain model to the HL7 Reference Information Model and of instances based on care plan templates to HL7 Clinical Document Architecture (CDA).

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