Medical Guidelines for the Patient: Introducing the Life Assistance Protocols

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Introduction

What will be the health problems of tomorrow?

- Demographic indicators, aging, and the **relevant increase of chronic diseases (2005: 60% of all deaths due to c.d.):** cardiovascular, cancers, chronic respiratory diseases, diabetes, etc…
  - Inversion of the % workers/non workers
  - Inversion of the % EU citizens in the world
  - Environment matters and related diseases
- Globalization (**economy**, disease, knowledge) and mobility of user (virtual or physical)
- The **economical viability** of the reimbursement process in respect of access, equity and solidarity
- Some key issues reported in WHO yearly surveys
**Rationale**

**Chronic Disease Management: Population Management**

**Deciding the right approach**
It is important to have the information and knowledge to be able to carry out a risk-stratification on local populations to identify those who are most at risk.

**Level 3**
As people develop more than one chronic condition (co-morbidities), their care becomes disproportionately more complex and difficult for them, or the health and social care system, to manage. This calls for case management - with a key worker (often a nurse) actively managing and joining up care for these people.

**Level 2**
Disease/care management, in which multidisciplinary teams provide high quality evidence-based care to patients, is appropriate for the majority of people at this level. This means proactive management of care, following agreed protocols and pathways for managing specific diseases. It is underpinned by good information systems - patient registries, care planning, shared electronic health records.

**Level 1**
With the right support many people can learn to be active participants in their own care, living with and managing their conditions. This can help them to prevent complications, slow down deterioration and avoid getting further conditions. The majority of people with chronic conditions fall into this category - so even small improvements can have a huge impact.
Figure 4 – Model of population management²¹, and cost per case²²
Chronic Disease Management and Shared Care

- Level 3: High complexity
- Level 2: High risk
- Level 1: 70-80% of CDM population

Rationale
Rationale

• **pHealth**
  - Citizen Centred Health Systems
  - Integrate disease *prevention, control* and *treatment*, into the *person’s daily life* in a personalized and non-invasive way.
    - Technology provides with interfaces, communications…
      - Non-invasive
      - Non-pervasive
      - Non-intrusive
    - But… How do we personalize? How do we integrate with the person’s daily life?
• In this context:

► The patient must be considered the main active actor in the care process, instead of the passive receiver of the actions performed by the caregivers;

► For the above reason, motivational aspects and possible non compliance must be accounted for in the core of the model, instead of being considered just as undesirable deviations from the normal path;

► In such a context, the recommendations and guidelines (actions) are usually less strict, in some cases even given without direct mediation of a health professional;

► On the other hand, the level of variability is greater and the need of adaptation to the patient’s life (preference and context) much higher;
Life Assistance Protocols (LAP) I.

**Clinical Practice Guidelines**
- Systematically developed statements to assist practitioner and patient decisions about appropriate health care for specific clinical circumstances (Inst. of Medicine, 92).

**Life Assistance Protocol (LAP)**
- A LAP is a set of guidelines, recommendations and prescriptions (actions) for a concrete need of a person, including not only health care actions but also lifestyle.
Life Assistance Protocols (LAP) II.

- **User’s needs categories:**
  - Pathologies: diabetes, hearth failure, overweight, ...
  - Special conditions: pregnancy, elderly, ...
  - Main concerns: stopping smoking, following a healthy lifestyle, ...

- **Actions to achieve goals.**
  - Actions represent the cycle (workflow) of the life of a person.
  - Each workflow’s stage takes into consideration: motivation, clinical status, personal context, etc.
• **LAP Framework**
  ▶ Conceptual model
  ▶ LAP workflow model
  ▶ LAP representation languages
  ▶ Execution model
  ▶ User Model (Virtual Ego)
LAP Conceptual model I.

• LAP conceptual model:
  
  ➤ LAP: is a set of guidelines, recommendations and prescriptions (actions) for a concrete need of the user. It includes a **general objective** and set of **stages**.

  ➤ STAGE: is the set of **active nodes** in a concrete moment of time, and may have an associated label. There are two special types of stages to be defined here, **initial** stages (usually one per LAP) and **objective** stages, that can be more than one.

• The latter will be reached whether the general objective of the LAP has been achieved or the patient is in a stage in which the LAP is not able to continue (i.e. the person needs to go urgently to a hospital).
LAP Conceptual model II.

- **NODE**: contains a set of actions, which are mutually independent, transactionally simultaneous and that will be executed over or by one or several determined actors. Each node will be defined by a description, a set of actions, indicators and reactions. A node could possibly include an explicit enumeration of user relevant data out of a predefined set (e.g. clinical record). A node is active if at least one action is in execution, otherwise it is inactive.

- **INDICATOR**: is a function of time and a (possibly empty) subset of the static or dynamic actors features to a discrete set of values (indicator labels).
LAP Conceptual model III.

- **ACTION**: is defined by an *activity*, an actor which executes the activity (executor) and one or more *actors* that benefit from the execution of the activity (addressee). The *executor* and the *addressee* can be the same actor.

- **ACTOR**: is considered to be any *user* of the system or the system itself, and it is defined by a set of static or dynamic features, that might be retrieved from the person’s clinical record, or even other sources containing non-clinical information, such as preferences, beliefs, habits, etc...

- **REACTION**: models the transition between nodes, and it is defined as a function of one or more nodes and one or more indicators labels to one or more nodes.

- **LAP templates**.
  - Templates Created using LAP’s concepts.
Workflow model

• **Formal framework.**
  - Taken from the preliminary studies of *Timed Parallel finite Automata* (TPA), and it is also based on the *Parallel finite Automata* (PFA).

• **Parallel finite Automata.**
  - An improvement of the *Determinist Finite Automata* (DFA) which executes parallel activities.
    - A parallel automaton implies more than one node active at the same time.
    - It is held by the concept of stages, that approximates the PFA to the DFA by joining the parallel active nodes into a different stage.

• **Time Parallel Finite Automata.**
  - Appends timers to the PFA by adding the concept of *Clocks* and also using the *Clocks’* timers as indicators
Definition 1: A Life Assistance Protocol is a tuple $LAP = \{A, \Delta, \Sigma, \Psi, N, Q, q_0, O, \gamma, \sigma\}$, where:

- $R$ is a finite set of typed features;
- $A \subseteq R^*$ is a finite set of actors, where each actor is characterized by zero or more features;
- $P$ is a finite set of activities;
- $\Delta \subseteq A \times P \times A^+$ is the set of actions, which are activities performed by one actor and received by one or more actors;
- $C$ is a finite set of Clocks;
- $T$ is a finite set of time labels that can be generated by the Clock set $C$;
- $\Phi$ is a finite set of symbols;
- $\Sigma \subseteq T \cup \Phi^+ \cup T \times \Phi^+ \cup \{\lambda\}$ is the finite input alphabet;
- $\Psi | \psi_k : C^* \times R^* \rightarrow \Sigma$ is the set of all possible indicators, where an indicator is a function of time (indicated by clocks) and actors features to the input alphabet;
- $N \subseteq \Delta^* \times \Psi^*$ is a finite set of nodes, where each node contains zero or more actions and zero or more indicators;
- $Q \subseteq N^+$ is a finite set of stages;
- $q_0 \in Q$ is the initial stage;
- $O \subset Q$ is the set of objective stages;
- $\gamma : N^+ \times \Sigma \rightarrow N^+$ is the transition function between nodes;
- $\sigma : Q \rightarrow Q$ is the transition function between stages.
Representación modelo

- **Two different levels:**
  - A representation language that allows the experts to design the LAPs.
    - With enough expressivity
    - Dissemination / Standardization
  - An execution language:
    - Compliant with the workflow model
    - Dependent on the execution model implemented
Representation Language
<table>
<thead>
<tr>
<th>ID</th>
<th>13</th>
</tr>
</thead>
<tbody>
<tr>
<td>NAME</td>
<td>Eligibility</td>
</tr>
<tr>
<td>DESCRIPTION</td>
<td>This indicator specifies if the user is eligible for participating in the challenge.</td>
</tr>
<tr>
<td>RANGE</td>
<td>True</td>
</tr>
<tr>
<td>DEFAULT</td>
<td>Registration</td>
</tr>
<tr>
<td>FORMULA</td>
<td>Directly read from the user's profile (ACTIONS). The evaluation of the registration information sets the indicator value to true if the user is eligible. The system evaluates the registration information and decides if the user has the profile for participating in the challenge.</td>
</tr>
<tr>
<td>ACTIONS</td>
<td>- Link to 'Lose &amp; Win' terms &amp; conditions</td>
</tr>
<tr>
<td></td>
<td>- Show 'Lose &amp; Win' Registration Form</td>
</tr>
<tr>
<td></td>
<td>- Evaluate registration information</td>
</tr>
<tr>
<td>INDICATORS</td>
<td>Eligibility</td>
</tr>
<tr>
<td>REACTIONS</td>
<td></td>
</tr>
<tr>
<td>Eligibility</td>
<td>Reaction</td>
</tr>
<tr>
<td>False</td>
<td>N3</td>
</tr>
<tr>
<td>True</td>
<td>N4</td>
</tr>
<tr>
<td>USER RELEVANT DATA</td>
<td>The website visitor shows interest in entering the challenge.</td>
</tr>
</tbody>
</table>

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The execution model must also be compliant with the workflow model

Solution based on a MultiAgents System Design
Execution model

• **Analysis of current commercial WFE’s**

  ActiveBPEL
  Bexee
  Bigbross Bossa
  Bonita
  Breeze
  Con:cern
  Enhydra Shark
  Freefluo
  Intalio
  **jBPM**
  J folder
  MOBE
  Open Business Engine
  OpenWFE
  OsWorkflow
  Pi Calculus for SOA
  PXE Process eXecution Engine
  Syrup
  Swish
  Taverna
  Twister
  wfmOpen
  XFLow
  XFlow2
  YAWL
Execution model & language

J boss + J BPM + J PBM designer (eclipse)

```xml
<?xml version="1.0" encoding="UTF-8"?>

<process-definition xmlns="urn:jbpm.org:jpdl-1.1" name="hearleaf">
  <variable name="Doctor">
    <assignment expression="user(doctor)"/>
  </variable>
  <variable name="Patient">
    <assignment expression="user(patient)"/>
  </variable>
  <start-state name="getPatientData">
    <task name="Patient's data" variable="Doctor">
      <controller>
        <variable name="FirstName" access="read,write,required"/>
      </controller>
      <variable name="LastName" access="read,write,required"/>
      <variable name="Age" access="read,write,required"/>
    </task>
  </start-state>
  <event type="code-change">
    <action name="action1" class="com.sample.action.StartProcess"/>
  </action>
  <transition name="gotoFixTherapy" to="FixTherapy"/>
</process-definition>
```
Implementation plans

• A twofold validation will be carried out.
  ► Before the execution model is defined, a set of experts will be elicited for the validation of the LAP model and the first LAP templates.
    • Those experts will be selected so that to have both a medical background and expertise in e-health and process management.
  ► On the second place, after the templates are implemented in an execution solution, the instantiated LAP will be validated by controlled pilot studies.
    • Including real actors and real health care organizations (HSR, LaFe), to assess its applicability and evaluate if those experiences show a tendency to the desired impact.
  ► As a result of these phases, a refinement of the templates and the model will be performed, setting the basis for the dissemination of them in wider forums.
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Questions?