SUPPORT FOR INTERDISCIPLINARY HEALTHCARE TEAMS

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Acknowledgements

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- Prof. Krzysztof Słowiński  
  Klinika Chirurgii Urazowej, Leczenia Oparzeń i Chirurgii Plastycznej,  
  Uniwersytet Medyczny, Poznań

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Outline

1. Introduction and research goals
2. Related work
3. Research plan and results
   • Empirical model of a team
   • Conceptual model of a team
   • Design and implementation of MET4
4. Case study: obesity in children
5. Conclusions and future work
Introduction and Research Goals
Introduction

• Increasing complexity of relatively frequent patient cases
• New patient management techniques – management workflows derived from clinical practice guidelines (CPGs)
• Typically a workflow needs to/should be executed by a team of healthcare (and other) practitioners

Teams have been reported to reduce hospitalization time and costs, improve service provision and enhance patient satisfaction, staff motivation and team innovation

• Successful execution of a workflow (⇒ provision of comprehensive care) requires collaboration and coordination

Understood also as associating specific tasks to appropriate team members

Models of Team Practice

Extensive research on collaboration in healthcare teams and multiple categorizations of team practice

**Multidisciplinary**
- Team members function in parallel
- They work relatively independently with little communication between them

**Interdisciplinary**
- Team members from different domains work together towards a common purpose
- They integrate services, communicate together and develop common understanding

**Transdisciplinary**
- Interdisciplinary team functioning with even high level of synergy

Interdisciplinary healthcare team (IHT) = a team of healthcare practitioners who work together towards a common goal for the patient

Variability in IHT

<table>
<thead>
<tr>
<th>Personnel</th>
<th>Roles</th>
<th>Ambulatory care</th>
<th>Emergent or critical care</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stable</td>
<td>Stable</td>
<td>Least prevalent</td>
<td></td>
</tr>
<tr>
<td>Variable</td>
<td>More prevalent</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Research Goals

Overall goal

To provide *methodological foundations* and *practical tools* to support IHT in providing care according to a workflow

Specific goals

To propose sufficiently expressive **models** of workflows and IHT

To propose **strategies** and **algorithms** for handling (creating, maintaining, distributing tasks) IHT when executing a workflow

To develop a **CDSS** that employs proposed models and implements proposed algorithms
Related Work
Related Work

“Colored” BPMN

Extension of BPMN (Business Process Model and Notation)

- Multiple roles and shared tasks
- Colors (instead of lanes) associated with individual and shared tasks

Related Work

**K4CARE**

- European project (FP6) aimed at providing knowledge-based e-services for managing elderly patients
  - SDA* representation for workflows
  - Ontological models of workflows, processed data and documents and practitioners (limited characteristics in terms of their abilities)
  - Multi-agent system to support execution of workflows by an IHT
- Limited evaluation in Pollenza, Italy
  - 23 volunteer elderly patients, 10 practitioners
  - Highly evaluated by physicians and head nurse for (semi-automatizing) administrative work

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Related Work

Resource Management Framework

- Formal resource management framework
  - Extensive description of resources required to execute processes, customized to a specific problem
  - Simplified (e.g., in comparison to BMPN) description of processes
- A prototype system simulation system
  - Experiments involving several ED scenarios
  - Minimization of the time spent in ED

Related Work

Patterns of Collaboration in Healthcare

• Goal-based workflow representation based on PROforma
• State-based exceptions for detecting obstacles and hazards and associated plans for handling them
• Formal description of two collaboration patterns
  • Assignment $\Rightarrow$ provider is accountable for outcome and responsible for handling exceptions
  • Delegation $\Rightarrow$ client is responsible for outcome and responsible for managing any exceptions that provider cannot handle
• Extensive description of practitioners (to ensure valid assignment/delegation), but no notion of a team

Related Work

Patterns of Collaboration in Healthcare

Fig. 2. (1) Client_assignment_pattern, (2) Provider_assignment_pattern. The hexagons represent goals, the triangles correspond to split points and the inverted triangles to join points.

Fig. 6. (1) Client_delegation_pattern and (2) Provider_delegation_pattern.
Research Plan
Research Plan

1. To define the **empirical model** (↔ practice-based model) of an IHT
2. To derive the **conceptual model** (↔ system-based model) of an IHT executing a management workflow
3. To propose **strategies and algorithms** to handle an IHT when executing a workflow
4. To design and implement **MET4** – a multiagent system to support workflow execution by an IHT
5. To implement several workflows (**pediatric obesity**, abdominal trauma, palliative care) within MET4
6. To perform clinical trial of MET4 with a selected workflow
Empirical Model of IHT
Empirical Model of an IHT

• General assumptions
  • IHT is created to handle a specific patient (*team-on-demand?*) and dissolved when management is finished
  • IHT has a leader that controls its operations – identifies tasks, delegates them to team members and makes relevant decisions

• Features (dimensions) characterizing an IHT

| Space       | • co-located → IHT members work closely together  
             | • remote → members are physically distributed |
|-------------|--------------------------------------------------|
| Time        | • synchronous → IHT members work at the same moments of time  
             | • asynchronous → IHT members work at different moments of time |
| Roles       | • stable → IHT members do not change roles  
             | • variable → IHT members may change roles |
| Membership  | • static → composition of an IHT does not change  
             | • dynamic → members may join and leave |
Empirical Model of an IHT

Team Formation

• Two-phase formation of a team
  1. Identification of the leader by some “external” administrative entity
  2. Identification of remaining team members by the leader (based on knowledge about skills and availability of potential team members, this can be supported by some administrative entity as well)

• Two types of team members
  • Core members – in direct and continuous contact with a patient
  • Non-core members – required on ad hoc basis

Decision about the type of a specific members is made by the leader taking into account patient management needs (workflow as a reference point)
Leadership

• Goals of the leader
  • To maintain a team (recruit new members and dismiss existing members)
  • To coordinate activities of team members and to solve conflicts
  • To make relevant decisions related to management

• Leadership may be static throughout the management process (acute condition) or it may change (chronic disease)
Empirical Model of an IHT

Task Delegation and Exceptions

• The leader delegates tasks to most appropriate team members (based on the required and possessed skills)

• If the selected member is not able to accept the task, the leader needs to find a replacement

Exception is defined as an inability to complete a task because of some external circumstances (i.e., drastically changing patient condition).

• Exceptions are handled by the leader

1. Leader delegates task $t_1$ to member 1
2. Member 1 is busy with another task and refuses to execute task $t_1$
3. Leader delegates task $t_2$ to member 2
4. Member 2 executes task $t_1$ and reports results to leader
5. Member 2 may report exception to leader
Empirical Model of an IHT

Communication

• Peer to peer with several explicit/direct (verbal, e-mail, notes) and implicit (CPOE, EPR) channels

• Explicit communication used to ensure proper delegation and coordination of activities
From Empirical to Conceptual Model

**Empirical model** (reality) --> **Conceptual model** (foundation of MET4)

1. IHT manages patient according to a *workflow*
2. Tasks from a workflow are tagged with *requirements*
3. Practitioners are characterized with *skills*

<table>
<thead>
<tr>
<th>Issue</th>
<th>Empirical Model</th>
<th>Conceptual Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Formation</td>
<td>Leader Administrative entity</td>
<td>Workflow-driven (matching requirements with skills)</td>
</tr>
<tr>
<td>Leadership</td>
<td>Team maintenance, task matching, decision making, exceptions</td>
<td>Decision making, exceptions; Workflow-driven otherwise</td>
</tr>
<tr>
<td>Task delegation</td>
<td>Leader</td>
<td>Workflow-driven (matching requirements with skills)</td>
</tr>
<tr>
<td>Exception</td>
<td>Leader</td>
<td>Leader</td>
</tr>
<tr>
<td>Communication</td>
<td>Direct and indirect channels</td>
<td>Selected direct channels</td>
</tr>
</tbody>
</table>

(Semi-) automatic execution of administrative activities
Conceptual Model of IHT
Conceptual Model

- Requirements and skills given in terms of capabilities
  
  \textit{Capability} = ability to perform a certain clinical task

- Capabilities associated with practitioners (\textit{possessed capabilities}), workflow tasks and arcs (\textit{required capabilities})

- Capabilities additionally characterized by competency score
  - \textit{Competency level} for possessed capabilities
  - \textit{Competency threshold} for required capabilities

Conceptual Model

- Competency level established according to
  - Expert knowledge, e.g., corresponding to the seniority level
  - Objective tests, evaluating capabilities in evidence-based practice

- Practitioner may be delegated a specific workflow task if
  1. She possesses all capabilities required by the task
  2. For all the required capabilities competency value ≥ threshold

- Analogous approach for appointing the leader → possessed capabilities matched against the required ones

IHT Handling Strategy

- A hybrid strategy that combines static and dynamic approaches to team creation and maintenance

1. Initially IHT includes the leader
2. Before executing a specific task check if IHT contains appropriate member
   - If yes, select the existing member
   - Otherwise, recruit a new member and select it
3. Delegate the task to the selected member
4. After executing the task check if the selected member possesses capabilities required by subsequent tasks
   - If yes, retain the selected member in IHT
   - Otherwise, dismiss the selected member
5. Members may leave the IHT on their own

- Limited “idleness” of IHT members at the cost of pausing the workflow execution if no appropriate member can be recruited
Design and Implementation of MET4
Design of the MET4 System

- MET4 – a multiagent system to support workflow execution by IHT (team maintenance, task delegation, decision support)
- Builds on our experience with MET3 and significantly expands it to support a team and handle diversified workflows

- Designed using the O-MaSE method
  - Flexible method for analyzing and designing multi-agent systems
  - Strongly rooted in software engineering (modified UML)
  - Constructs a sequence of models that translate requirements into detailed design specifications
  - Available toolset (agentTool 3 – a plugin for Eclipse)
Agent Model for MET4

- Agent classes
- Non-agent components
Implementation of MET4

• Functionality related to agents and workflows implemented using WADE (extension of JADE)
• Domain models and data repositories implemented using Protégé
• Touch-based interfaces for mobile devices (Android, iOS?)
Case Study: Obesity in Children
Obesity in Children

• Problem of increasing prevalence and importance
  • 29% of adolescents in Canada with unhealthy weight (2007)
  • 70% of adults obese or overweight in 2040

• Management in dedicated facilities, e.g., Centre for Healthy Active Living at CHEO

• An organizational workflow used at CHEO requires a team composed of multiple specialists
  - Pediatric endocrinologist
  - Registered nurse
  - Psychologist
  - Child and youth worker
  - Social worker
  - Exercise specialist
  - Dietitian
Obesity Management Workflow

Assessment Sub-workflow

- Physical Assessment
- Biochemical Assessment
- Dietary Assessment
- Fitness Assessment
- Psychological Assessment

- do_diagnosis (3)
- plan_medical_therapy (3)
- do_physical_assessment (1)
- do_biochemical_assessment (2)
- do_dietary_assessment (3)
- do_fitness_assessment (3)
- do_psychological_assessment (3)

Therapy Planning

Therapy Reconciliation

Therapy Implementation

Repeated Assessment

Therapy Modification

Therapy Successful?

Yes

No
Operations of MET4

IHT = \{pa-md1, pa-rn1\}
Conclusions and Future Work
Conclusions

• Empirical model of an IHT representing reality
• Conceptual model of an IHT built around the concept of capability
• Hybrid strategy for IHT creation and maintenance
• Design and implementation of MET4 (O-MaSE, WADE, Protégé)
• Workflow for pediatric obesity

Support for coordination
Support for IHT variability
Ongoing and Future Work

- Extensions of the conceptual model and the handling strategy
  - Emergency/high-priority tasks
  - “Bundles” of tasks executed by the same IHT member
  - Tasks executed simultaneously by several IHT members
  - Patient-centered care and patient preferences
- Improved implementation of the MET4 system
- Simulation experiments to verify the handling strategy
- Implementation of other management workflows (e.g., ovarian cancer) within MET4
- Clinical tests of the MET4 system
Thank you for your attention
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