Supporting an Interdisciplinary Healthcare Team with a Multi–Agent System

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INTRODUCTION

Increasingly complex patients' health conditions have necessitated new approaches for patient management. One of them has been to draw upon research on clinical practice guidelines to develop clinical management workflows, broadly defined as a sequence of steps corresponding to clinical tasks and decisions, in order to structure all activities associated with the patient management process. These workflows can be processed (e.g., analyzed and/or executed) by a computer system (Latoszek-Berendsen, Tange, van den Herik, & Hasman, 2010) but it becomes challenging when tasks need to be performed by multiple practitioners. This situation occurs because complex and/or chronic diseases often rely on care delivery by an interdisciplinary healthcare team (IHT) consisting of physicians, nurses, and other healthcare practitioners.

Members of an IHT share a common goal of providing comprehensive and effective care to a patient. In order to achieve this goal they collaborate and communicate by exchanging information about the patient's state and care provided either directly or indirectly (e.g., through a patient record), as well as coordinate their activities (Ruan, MacCaull, & Jewers, 2010). Collaboration is usually understood as working together to achieve this common goal, while coordination is interpreted as "managing interdependencies between activities performed to achieve a goal" (Symon, Long, & Ellis, 1996). Benefits of care delivery by an IHT include improved patient satisfaction, improved quality of care, decreased clinical staff turnover, and improved cost-effectiveness of care delivery (Aston, Shi, Bullot, Galway, & Crisp, 2005).

Research on typologies of an IHT (Andreatta, 2010) has shown that there exists variability in terms of a team's structure (i.e., members may join or leave the team) and role assignment (i.e., members may play different roles that do not have to be predetermined or defined strictly by their specialties). Han-

dling this variability, especially related to role assignment, requires characterization of the healthcare practitioners at a more specific level than just categorizing by clinical specialty. Gardner, Hase, Gardner, Dunn, & Carryer (2008) proposed to characterize practitioners with capabilities, and while that work has been directed at nurse practitioners, capability characterization can be extended to other healthcare practitioners and be used for defining a conceptual model of an IHT.

This chapter describes a clinical decision support system (CDSS) called MET4 that supports coordination and collaboration among IHT members. The system uses the concept of capability to form and maintain an IHT, to assign team members to tasks from a workflow, and to support them in executing these tasks. Design of the MET4 system follows a multi-agent system (MAS) architecture and builds on earlier research of the authors, where MAS was combined with an ontology-driven design to create an environment (called MET3) for developing a family of CDSSs for supporting individual physicians during an emergency patient management process (Wilk et al., 2013b). MET4 extends this support for an IHT and for other management processes that are not limited to emergency patients. Selected operations of the MET4 system are illustrated using a case example of management of clinical pediatric obesity.

BACKGROUND

The issue of collaboration among multiple decision-makers has been the subject of research in fields such as computer supported cooperative work (CSCW) (Weerakkody & Ray, 2003), where it has produced a blueprint for designing collaborative systems for improving team performance (Fitzpatrick & Ellingsen, 2012). Considering that patient management processes are complex, this blueprint has also been applied in healthcare (Fitzpatrick & Ellingsen, 2012). However, most of the healthcare workflow management systems have primarily been concerned with representing workflows or with scheduling activities from a workflow, with less emphasis on coordinated care delivery by an IHT. This is well illustrated with the HealthFlow system (Huser, Rasmussen, Oberg, & Starren, 2011) that offers a set of user-friendly tools for creating and maintaining workflows while providing no direct support for IHT collaboration and coordination. Another example is the HeCaSe2 system (Isern & Moreno, 2010) that was designed to align activities and services across a number of healthcare organizations.

It has been shown that the MAS paradigm can be used for modeling CSCW requirements including the use of heterogeneous and distributed decision-makers, distributed management of data, and remote collaboration (Bergenti & Poggi, 2010). An example of a MAS implementation in healthcare is the K4CARE system that supports care provision to elderly patients (Isern et al., 2011). In the K4CARE system healthcare practitioners are assisted by agents whose actions are governed by intervention plans corresponding to workflows. While K4CARE provides a foundation for developing a CDSS for an IHT, its ability to support coordination of the tasks and for maintaining a team is restricted, as team members have to be explicitly associated with tasks they are able to execute and members are dynamically recruited to execute specific tasks.

The research presented in this chapter has drawn from the K4CARE system's foundations and together with the earlier research of the authors has resulted in the MET4 system to support coordination and collaboration within an IHT. Specifically, MET4 follows a workflow for proper alignment of tasks to be executed and it relies on the concept of capability to characterize team members and workflow tasks. This allows for dynamic creation and maintenance of a team during execution of a workflow and allows for multiple team members to compete for execution of a given task.

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