Standardizing Inter-Institution Care via Ontologically-Modelled Clinical Pathways

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Abstract

In this paper we pursue the standardization of care for a specific condition across multiple institutions. Our approach is to represent institution-specific Clinical Pathways (CP) using an ontological model and then aligning the common care activities between multiple CP, based on their semantic descriptions, to generate a standardized care model. We developed an execution engine that transforms the ontological standardized care model to a state-graph that can be executed with patient data and practitioner input at the point-of-care.

Keywords:

Clinical pathways, Prostate cancer, Ontologies, Semantic web, Knowledge representation

Introduction

Despite the presence of evidence based clinical guidelines aiming to standardize care, in practice, health institutions tend to differ in their care practices due to local resources constraints, care team responsibilities and policies. There is a push for inter-institution standardization of care for specialized conditions, especially within a region to ensure (a) equity of care across different institutions; (b) inter-institution transfer of patients; and (c) uniform implementation of evidence-based guidelines. But, it is a significant challenge to develop an inter-institution standardized care model by manual alignment and reconciliation of a range of complex institution-specific care activities, constraints and preferences.

We present a semantic web based inter-institution care standardization framework that offers a standardized inter-institution care model, achieved through the alignment of multiple Clinical Pathways (CP), to standardize care.

Methods

Our approach is to standardizing inter-institution care is to align the institution-specific CP at the knowledge modeling level. As per our approach we (a) represent the different CP using a common semantically-rich formalism; and (b) use the semantic descriptions of different CP to align their common elements (care tasks, task sequences and clinical criterion for tasks/decisions) to achieve a standardized care model. The resultant is a *maximal inter-institution standardized care model* that aligns 'functionally similar' care activities, whilst allowing individual institutions to *branch-off* to pursue specific care activities and then *merge* back to the standardized care model. In this way, our standardized care model represents a maximal overlap between different CP, whilst maintaining the individual nature of each institution's CP.

Our framework has been evaluated by instating three prostate cancer CP from different institutions, and the prototype system can standardize care across three three institutions. We present the design of our standardized care framework.

Phase 1: CP Knowledge Engineering

This phase involved working with domain experts and practitioners to (a) chart the institution-specific CP based on current practices; (b) identify key care activities; (c) sequence the set of tasks to constitute a high-level procedure/plan; (d) explicate the key determinants of procedures and care tasks; and (e) standardize the terminology and function of the identified concepts using a terminology system.

Phase 2: CP Knowledge Modeling

This phase involved the development of an inter-institution care model by: (1) Abstracting higher-level CP plans and lower-level tasks from CP. Tasks have localized constraints, executional details, sequencing information and local outcomes; and (2) Establishing task-level overlaps between different CP based on the functional pragmatics of the tasks and their associated outcomes. We developed an OWL-based *Prostate Cancer Clinical Pathway (PCCP) ontology* as an interoperable template to represent and computerize CP that identifies both domain and workflow concepts—domain concepts capture prostate cancer care knowledge, whilst the workflow concepts manifest the care process in terms of the sequence and constraints of the care activities. To align common aspects of ontologically-modeled CP, we introduced two constructs: (a) *merge* nodes that model common interoperable tasks across different institutions; and (b) *branch* nodes that model tasks that are specific to a particular institution.

Phase 3: CP Knowledge Execution

This phase involved the development of an execution engine to execute the standardized inter-institution PCCP based on the patient's location to manage prostate cancer care. Our CP execution approach was to develop a lightweight solution—i.e. without employing rules and reasoning engines—leveraging the workflow sequence captured within the RDF graph of the PCCP ontology and traversing through the RDF graph, with patient data, to execute the CP for a patient.

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