

Characterizing workflow for pediatric asthma patients in emergency departments using electronic health records



Mustafa Ozkaynak^{a,*}, Oliwier Dziadkowiec^a, Rakesh Mistry^b, Tiffany Callahan^a, Ze He^c, Sara Deakne^d, Eric Tham^e

^a College of Nursing, University of Colorado-Denver | Anschutz Medical Campus, Aurora, CO, USA

^b Section of Emergency Medicine, Children's Hospital Colorado, Aurora, CO, USA

^c College of Engineering, University of Massachusetts, Amherst, MA, USA

^d Children's Hospital Colorado, Aurora, CO, USA

^e Seattle Children's Research Institute, Seattle, WA, USA

ARTICLE INFO

Article history:

Received 4 February 2015

Revised 8 July 2015

Accepted 17 August 2015

Available online 30 August 2015

Keywords:

Workflow

Emergency departments

Visualization

Markov Chains

Asthma

ABSTRACT

Objective: The purpose of this study was to describe a workflow analysis approach and apply it in emergency departments (EDs) using data extracted from the electronic health record (EHR) system.

Materials and Methods: We used data that were obtained during 2013 from the ED of a children's hospital and its four satellite EDs. Workflow-related data were extracted for all patient visits with either a primary or secondary diagnosis on discharge of asthma (ICD-9 code = 493). For each patient visit, eight different *a priori* time-stamped events were identified. Data were also collected on mode of arrival, patient demographics, triage score (i.e. acuity level), and primary/secondary diagnosis. Comparison groups were by acuity levels 2 and 3 with 2 being more acute than 3, arrival mode (ambulance versus walk-in), and site. Data were analyzed using a visualization method and Markov Chains.

Results: To demonstrate the viability and benefit of the approach, patient care workflows were visually and quantitatively compared. The analysis of the EHR data allowed for exploration of workflow patterns and variation across groups. Results suggest that workflow was different for different arrival modes, settings and acuity levels.

Discussion: EHRs can be used to explore workflow with statistical and visual analytics techniques novel to the health care setting. The results generated by the proposed approach could be utilized to help institutions identify workflow issues, plan for varied workflows and ultimately improve efficiency in caring for diverse patient groups.

Conclusion: EHR data and novel analytic techniques in health care can expand our understanding of workflow in both large and small ED units.

© 2015 Elsevier Inc. All rights reserved.

1. Introduction

Systematic workflow studies that examine procedural aspects of work in health care delivery settings are essential to the identification of organizational design flaws and bottlenecks [1–3]. Workflow studies assist in successful implementation of organizational, policy-related, and technological interventions that improve care delivery [4–8]. In order to make informed changes to maximize resources and improve care, efficient data collection and analysis methods are required. Methodological challenges are the

most significant barrier to delivering the promised benefits from workflow studies [2,9]. Clinical workflow directly impacts patient safety and the quality of clinical care, yet existing methods to describe clinical workflow that examine the linkages between clinical workflow and patient outcomes are inefficient and limited in response to rapid clinical changes [2,10]. Although current qualitative or quantitative field methods such as observations and interviews are useful for rich description of phenomena in context, four interrelated limitations exist: (1) qualitative designs do not lend themselves to quantitative analysis; (2) descriptions are resource-intensive and impractical for large-scale studies; (3) even quantitative field approaches yield small sample sizes; (4) findings are descriptive, thereby limiting conclusions about statistical inferences between workflow and outcomes.

* Corresponding author at: Campus Box 288-18, Education 2 North Building, 13120 E. 19th Avenue, Room 4121, Aurora, CO 80015, USA. Tel.: +1 303 724 8273; fax: +1 303 724 8559.

E-mail address: Mustafa.ozkaynak@ucdenver.edu (M. Ozkaynak).

The purpose of this study was to describe a workflow analysis approach (Fig. 1) and apply it in an academic children's hospital emergency department (ED) and its four satellite ED clinics (SC), using data extracted from their EHR system. Data was analyzed through; (1) Visualization and (2) Markov Models. Visualization allows exploration of workflow patterns and Markov Models allow for quantification of workflow patterns and establishment of the relationship between workflow and patient outcomes. We define workflow as the "sequence of activities to provide care for a patient [11]." The novelty of this approach is establishing a quantitative relationship between the workflow and the patient, as well as other outcomes of interest (e.g. length of stay) in a health care setting.

This study introduces a new approach that will utilize the full potential of (a) electronic health records (EHR) as the data source for workflow research and (b) visualization and Markov Chains as quantitative data-analysis techniques. Although EHR systems were designed and are primarily used for patient-care purposes, secondary use of data can potentially provide insight into workflow characterization [12–14]. EHR systems house real-time, high-volume, low-cost workflow data and capture massive numbers of clinical and non-clinical data related to patient care (e.g. event logs, medication administration data, orders and procedures, etc.). A high volume of data permits utilization of quantitative-analysis techniques, such as visualization and Markov Chains [13].

Visual representations and interaction techniques take advantage of the eye's "broad-bandwidth pathway" to the mind and allow users to see, explore, and understand large amounts of information [15]. Visualizations can provide cognitive support by (1) exploiting the advantages of human perception (such as parallel visual processing) and (2) compensating for cognitive deficiencies, such as limited working memory. Visualization supports data cleaning and sequence-pattern discovery [16].

Markov models are probabilistic modeling methods used for temporal sequence analysis [17,18]. These models have deep roots in operations research literature, and provide important insights to optimize use of resources by describing and predicting temporal relationship among "states" under given constraints [19–21]. In health care delivery, Markov models have been applied to simulated data [13] and has the potential to be applied to the field data [12,22]. Visualization and Markov Models can also complement each other to model clinical workflow, because visualization facilitates pattern discovery and Markov Models statistically model the previously identified workflow patterns [23]. The purpose of this study was to evaluate the capabilities of visualization and Markov Models, to model and analyze workflow using data from the EHR.

We selected EDs to demonstrate the viability of the approach because of the dynamic and high variability of ED workflow [3,24]. Additionally, accurate description of the workflow requires the use of large sample sizes that EHR data can provide. EHR data have the potential for systematic quantification of variability in ED activities and identification of workflow patterns that could lead to better or worse patient outcomes.

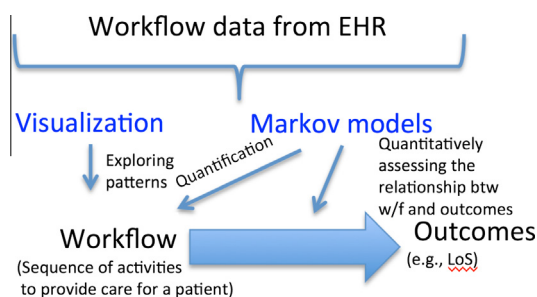


Fig. 1. Proposed approach to analyzing workflow in clinical settings (btw = between; w/f = workflow; LoS = length of stay).

For this study, workflow pertaining to ED care for exacerbations of asthma is examined. Asthma is the most common chronic condition in pediatrics and is a leading cause of ED visits [25,26]. Treatment of asthma in the ED requires involvement from multiple providers, including triage nurses, respiratory therapists, and medical providers. More importantly, emergency treatment of asthma is time-sensitive, since early administration of therapies and repeated clinical assessments are required for improved outcomes [27]. As a result, the interface of ED providers and EHR is essential to the quality and timeliness of clinical care for children with asthma.

We examined workflow for only one specific diagnosis (i.e. Asthma) to control disease specific variation in workflow. Importantly, visualization and Markov Chains for asthma workflow research should also be applicable to other clinical conditions in EDs.

2. Materials and methods

To demonstrate the viability and benefit of our workflow analysis approach, we applied it to the analysis of EHR data in a pediatric hospital ED and its four satellite clinics. This secondary analysis of EHR data used advanced visualization and first order discreet time Markov Chains (DTMCs) to examine EHR data to reveal activity sequence patterns (i.e., temporal relationships among patient-care related activities) in a children's hospital ED and its satellite ED clinics (SCs). Consistent with the cooperative nature of care delivery in EDs, this study utilized a patient-oriented workflow approach [24], defining workflow as a sequence of activities by multiple, interdependent ED-staff members, during the care of a single patient. Each workflow instance represented a patient-care episode.

2.1. Settings

Patient episodes were identified in the main hospital ED and its four satellite ED clinics (SC-1 through SC-4). The main ED (Children's Hospital Colorado) receives nearly 70,000 visits per year. It serves as a regional Level I Regional Pediatric Trauma Center, delivering emergency care to the geographic area that encompasses Colorado, Wyoming, Montana, South Dakota, Nebraska, Kansas, and New Mexico. The main ED has 40 private patient care rooms and eight observation rooms. The four satellite clinics accounted for an additional 60,000 visits per year. The number of private and observation rooms at the satellite clinics were 12, 9, 10 and 8 in SC1, SC2, SC3 and SC4 respectively.

2.2. Sample

A total of 134,596 children were seen across sites between January 1 and December 31, 2013 (Table 1). Census at the main ED is higher than at the satellites. At all five settings, the majority of the patients were walk-ins; the number of patients arriving by ambulance was substantially lower at the satellite clinics. The age and gender distributions across the five settings were similar.

Asthma diagnoses ranged from 4% to 6% among settings. The numbers (% of total) of patients with a primary or secondary diagnosis of asthma were 2935 (4.33%), 522 (4.22%), 742 (6.35%), 1348 (4.45%), and 530 (4.25%) in main ED, SC-1, SC-2, SC-3 and SC-4 respectively.

2.3. Data collection

The research informatics department at the Children's Hospital Colorado extracted the data (i.e. time stamped event logs) from the

Download English Version:

<https://daneshyari.com/en/article/6928061>

Download Persian Version:

<https://daneshyari.com/article/6928061>

[Daneshyari.com](https://daneshyari.com)