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Health Analytics to Manage Turbulence in Patient Flow: A Field Study of Transitions in Care Processes

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ABSTRACT

The potential use of advanced data analytics in healthcare has seen significant interest in both research and practice. Fundamentally, the contribution of IS and analytics research in healthcare is to identify and assess the impact of interventions that can make a significant difference to the quality and cost of care. The American Heart Association (AHA) recently issued a scientific statement calling for research on heart failure transition care to identify impactful processes and practices. This paper presents our conceptualization of ingress and egress patient flow management to investigate the impact of transition care. The larger research question we attempt to address is: *How can we identify and inform impactful transition of care interventions that manage demand uncertainty, and improve resource allocation and utilization, while providing improved quality of care for heart failure patients?* We present preliminary results of text-mining and process analytics and discuss our plans for quasi-experimental validation.

Keywords

Advanced Analytics, Text Mining, Process Analytics, Heart Failure, Transition of Care

INTRODUCTION

Managing and reducing costs while improving quality is a perennial business challenge. Specifically, in healthcare many recent studies addressed this issue (eg. Helm, AhmadBeygi and Van Oyen, 2011; Theokary and Ren, 2011; Helm, Alaeddini, Stauffer, Brethauer and Skolarus, 2015). Much research attention has focused on the need to develop and apply analytic techniques to the large amount of data that is made available using EHR and other new technologies. In IS and healthcare operations, analytics is applied to identify impactful ways to reduce random and uncontrolled variability in demand by managing uncertainty while investigating techniques to manage capacity to meet the needs of demand uncertainty. For example, Salzarulo, Bretthauer, Cote and Schultz (2011) study how high levels of variability in demand for health services, evident from ad-hoc patient arrivals, impact healthcare providers. They identify systematic inflows of patients and the consequent ability to schedule resource allocation, as well as on-demand availability of patient information, as influential factors in improving service quality and managing costs. Venkat, Kekre, Hegde, Shang and Campbell (2015) analyze adult emergency room visits to explain strategic management of health care operations and study the financial workflows of the emergency department. They identify the need to reengineer healthcare operations in a manner that makes appropriate strategic consideration of allocating resources and controlling costs, while improving the impact on population health and patient satisfaction.

Review of these and many other related studies, identifies a convergent need for analysis of business processes in order to identify and study the impact of innovative management interventions. these interventions can reduce or manage demand uncertainty, improve the efficiency and effectiveness of resource allocation and resource utilization. Furthermore, these interventions help the healthcare organization to meet the challenge of providing improved quality of care for patients while meeting the demands of external regulatory and insurance agencies. This motivates our research to *identify and inform impactful transition of care interventions that manage demand uncertainty, and improve resource allocations and utilization, while providing improved quality of care for heart failure patients*.

The health literature identifies transitional care programs as a complementary approach to manage demand uncertainties that the healthcare system faces while improving the quality of care provided. *Transitional care refers to actions designed to coordinate the continuity of healthcare as patient transfer from one care facility to another.* Naylor, Aiken, Kurtzman, Olds and Hirschman (2011) identify these points of transition as areas that contribute to high healthcare costs and low quality of care associated with increased rates of readmission. Stamp, Machado and Allen (2014) provide an integrative review of the clinical and operational impact of transitional care programs on heart

failure patients. However, there is little research that investigates the impact of transitional care programs on health care systems from an information systems perspective. We argue that IS can study the coordination and collaboration of efforts to ensure smooth transitions of information to ensure the effective care transitions for the patient. Recognizing the importance of this need, the American Heart Association issued a scientific statement in 2015 (Albert et al, 2015) calling for research on heart failure transition care to identify best practices that ensure economically and clinically effective and feasible transition clinics. Mechanisms to manage the inflow of patients and transition care programs are complementary interventions. Management of healthcare organizations can use these interventions to systematically administer the complete care continuum. Little research examines how these complementary mechanisms together can be used to improve patient outcomes by coordinating the ingress and egress patient flows. This paper is motivated to address this issue.

The following section presents background information about the case organization and presents an analysis of the nature of the problem and its implications. We specifically focus on the business processes and issues related to costs and quality of care provided for heart failure and heart failure patients. We present related research that sheds light on the current literature related to transition clinics and their impact on various aspects of the cost and quality of care. An analysis of the case organization, informed by the available extant research on the topic of transition care in heart failure management, provides the basis for the development of propositions that can be used to examine the impact of transition clinics on this important healthcare issue. We discuss our approach to the problem and the current progress. We present potential contributions of our multi-method investigation that we hope to discuss in further detail at the workshop. While the research project is on-going, this paper presents our approach and direction as well as its implications for the design of effective systems that incorporate appropriate communication and coordination mechanisms to manage the business processes related to effective management of care for heart failure patients.

CONTEXT: CASE ORGANIZATION

Here, we introduce our in-depth multi-method research investigation into the impact of transition clinics on the quality and cost of care. Specifically, we investigate the efficacy and impact of *transition clinics (TC)* as management interventions to implement transitional care programs at a large, not-for-profit network of health care providers serving multiple communities and counties in the eastern US, with over 10,000 employees and 1000 physicians. We refer to this as Wellness Central for the purpose of this paper – the identity of the organization has been altered to preserve anonymity.

Wellness Central provides comprehensive care for patients from multiple demographic and socio-economic backgrounds. Many patients do not have the education and/or aptitude to understand the nature of care required for self-management of their heart failure. In addition, the economic background of many patients are such that they are not able to afford medication or observe self-care necessities such as managing the type and quality of food for sodium and water intake levels. Weight management, particularly in the presence of co-morbidities such as diabetes or renal failure becomes a confounding factor. Further complications arise due to not having, or not being able to obtain, a primary care provider (PCP). Therefore, patients revert to the Emergency Department (ED) for conditions that could be handled by PCPs in a much more cost effective manner. Care providers describe situations where the emergency department and their related ambulance services are used as a "taxi service" to serve the needs of some chronic patients. These factors contribute to the challenging and complex environment of serving the care needs of heart failure patients in a contemporary urban environment.

The characteristics of the care environment also pose challenges to providing cost-effective quality care in a coordinated manner. Wellness Central manages care through various departments including the ED, the Heart and Vascular center, as well as multiple specialized care facilities such as renal and pulmonary clinics. In addition, multiple PCP offices are affiliated with Wellness Central and coordinate specialized or acute care of their patients with them. Many patients have comorbidities with sometimes chronic health conditions. These patients need to be seen by multiple clinics and care facilities that coordinate their care through the larger system that Wellness Central serves. Doctors and care providers at these facilities are under significant time pressures and carry full workloads. Many of these facilities have various levels of implementation success with their electronic medical record (EMR) systems and other systems for medical and business operations related records. Coordinating care delivery through effective communication among the care providers is very complex and challenging.

We focus on Advanced Heart Failure Care (AHFC) at Wellness Central that provide a single point of egress from the health system to manage the nature and frequency of their patients' visits to Wellness Central, thus managing subsequent ingress. These are represented in the scheduling in figure 1 and 2 respectively.

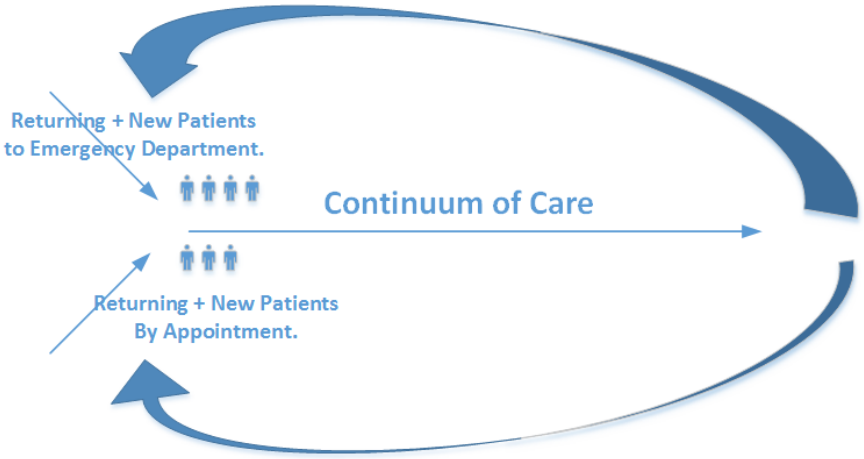

Figure 1: Current patient flows along the continuum of care are highly unscheduled, with most patients arriving from Emergency Departments on an ad-hoc basis.

The transition clinic does not need to see all patients from all related clinics in the Wellness Central ecosystem of care. Cardiologists at Wellness Central point out that certain patients with specific conditions should be seen by the transition clinic at the AHFC. For example, dialysis patients from the renal clinic that do not present heart failure symptoms such as shortness of breath and/or sharp weight gains in a day or a week may not need to be seen by the heart failure group – yet they often are. On the other hand, patients from the oncology clinic may develop complications due to the effects of chemotherapy and should be assessed by heart failure experts, irrespective of the symptoms that they present. These, and a host of similar conditions, present a wide range of opportunities to improve the management of demand for services at the heart failure clinic and improve the specificity of the care provided to patients. They present significant potential for the cost and quality of care that can be provided for patients.

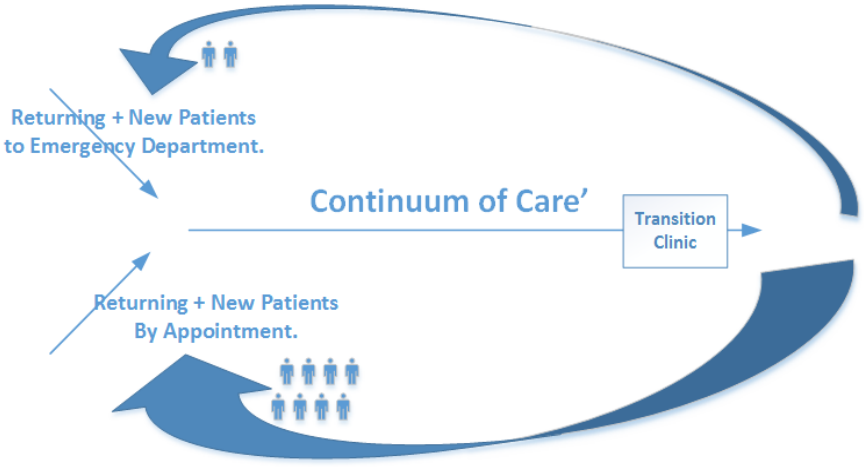

Figure 2: Transition clinics manage the egress patient flows by shifting patients to a scheduled pattern of arrival, thus systemizing the demand flow.

In the schematic shown in figure 2, we illustrate the care continuum following the introduction of a transitional clinic as a mandatory egress-step in the care process for all heart failure patients, before they are discharged. This is proposed to affect the desired change of reducing the unscheduled demand placed on the system by the highly variable emergency department visits and moving them to a scheduled and more systematic flow of patients that are seen by appointment.

METHODOLOGY AND PRELIMINARY RESULTS

We employ a multi-method design to conduct our in-depth study of value of the transition clinic to the AHFC from a quality and cost of care perspective. We use case-study and qualitative approaches to identify the nature and characteristics of patients from the multiple *touch points* where both clinical and administrative staff interact with patients. Moreover, we include the clinical and administrative perspectives of personnel from the accountable care organization (ACO) that has direct financial and clinical interests in the AHFC. Table 1 shows the data we collected, the methodology employed and the related outcomes.

Data	**Approach**	**[Expected] Outcome**
Semi-structured Interviews	Axial Coding, recursive abstraction Text Mining	Convergent set of concepts related to HF Quality of Care and Cost of Care influencers.
Quality Management and Improvement Documents	Content Analysis	Analysis of continuum of care workflow of HF Patients.
Activities, actors, roles and information from multiple touchpoints on HF continuum of care	Workflow Analysis identifies errors and possible interventions	Items and Functional Requirements, Potential Causes of Failure

Table 1: Data, Approach and Expected Outcomes.

Analysis of multiple perspectives allow us to identify and analyze patient workflows, and to model and study the impact of introducing the transition clinic on the patient flow, the clinical workflow and the administrative workflow.

We conducted multiple data gathering sessions where we did field studies, interviews, observations of clinical and administrative staff and well as shadowing of care providers as they go about treating heart failure patients. Table 1 shows the source and number of observations involved in the data collection for our study.

Source	**# of interviewees**
Cardiologists and Heart Surgeons	4
ED Specialists	2
Pharmacists	2
Nurse Practitioners and Physician Assistants	4
Nurse Director (CHF Unit)	1
Nurses	5
Community Paramedic	1
Quality Manager (ACO Unit)	3
Analytics and EMR Administration	3

Table 2: Sources of Qualitative Data Collection.

We sought to first identify the critical concepts and links that comprise the ontology of transition of care in heart failure across the range of sources in our qualitative data. The interviews and observation notes were transcribed and processed using SAS Enterprise text miner. Text mining allows us to identify the underlying concepts contained in the interview transcriptions and unearth the primary concepts and their relationships with each other. Figure 3 illustrates our sample outputs from SAS Text mining and identifies the convergent set of concepts related to the quality of care and cost of care influencers for heart failure patients at Wellness Central.

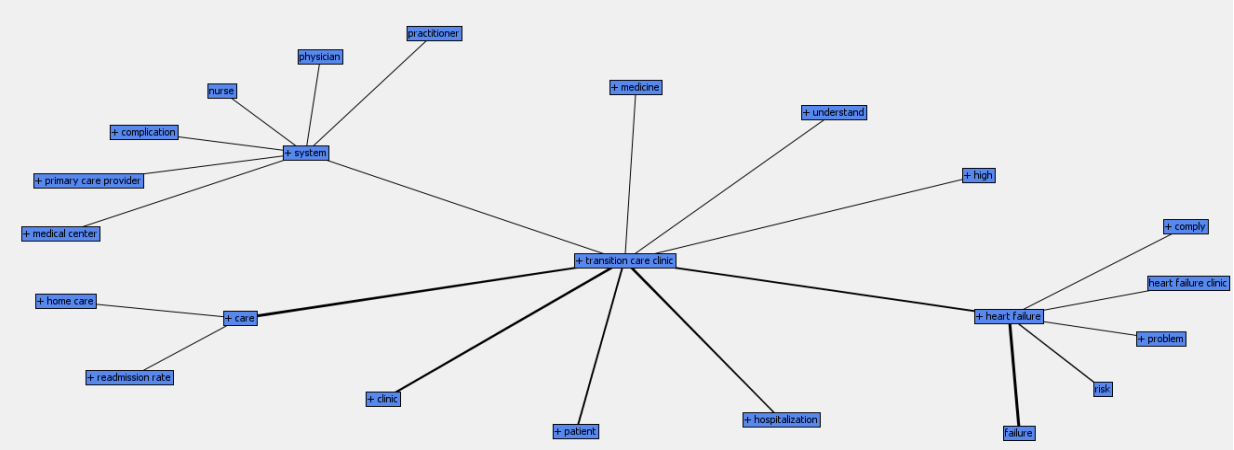

Figure 3: Text Mining to identify the Ontology of Heart Failure Transitions of care – Concepts and links.

For example, the text mining identified that the quality and cost of care in the heart failure is directly related to readmission of heart failure patients. The concept of heart failure is directly linked to compliance, risk and hospitalization as identified by the text mining algorithm and shown in Figure 3. These concepts were further elaborated and process workflow analysis was conducted to develop the transitions of care workflow for effective transition of care for the heart failure clinic at Wellness Central. This is shown in figure 4 below.

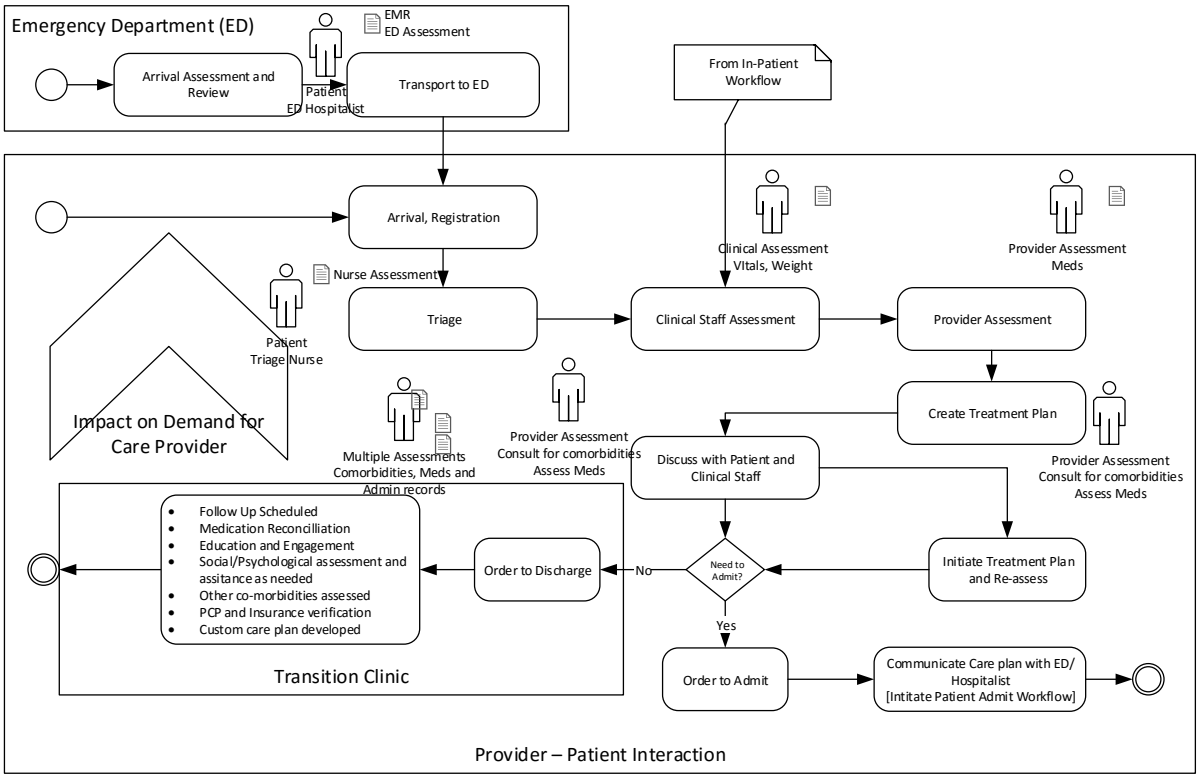

Figure 4: Analysis of Workflows and information flows in the transitions of care in Inpatient and ED based care of Heart Failure patients.

The accuracy of the workflow is validated by verification from the interviewees, including the care providers and hospital administration. This provides the basis to propose systemic interventions and measure their impact on emergency department visits. At the current stage, we have investigated ingress and egress patient flow management techniques, including scheduled visits and post-discharge assessment mechanisms that directly impact the cost and quality of care. We expect to present preliminary results at the conference.

CONCLUSION AND ON-GOING RESEARCH

Systematic review of the literature identifies a convergent need for research to study the impact of transition of care interventions in managing demand uncertainty and improving the efficiency and effectiveness of operations, while simultaneously helping healthcare organizations provide improved quality of care for patients. This motivates our research to *identify and inform impactful transition of care interventions that manage demand uncertainty, improve resource allocations and utilization, while providing improved quality of care for heart failure patients*. Here we present the results of exploratory research, using text mining and workflow analysis, to identify the ontology of transitional care using qualitative data. This includes identification of the key concepts and relationships involved in the study of transitions of care. Our ongoing research aims to collect empirical evidence and support hypothesis testing on the efficacy of management interventions, guided by this ontology.

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