Healthcare Delivery Systems

Sponsor: IE, Society for Health Systems

Sponsored Session

Chair: Teresa Wu, Arizona State University, Tempe, AZ, United States of America, teresa.wu@asu.edu

1 - Ambulance Flow Control through Ambulance Diversion and Destination Policies

John Fowler, Professor, Industrial Engineering, Arizona State University, CIDSE, Tempe, AZ, 85287, United States of America, john.fowler@asu.edu, Adrian Ramirez, Teresa Wu, Esma Gel

Overcrowding episodes in ED’s across the United States have caused concern in multiple aspects, including long waiting and boarding times. This research proposes ambulance flow control to allocate patients to the appropriate facility in order to find Pareto improvement in the performance of an emergency care system. The proposed framework based on simulation finds an effective use of the resource pool to receive the appropriate level of care as soon as possible. Genetic algorithms and approximate dynamic programming are discussed to assess the ambulance diversion and destination policies.

2 - Designing, Improving & Efficiently Operating Hospitals with Help from GE’s Generic Modeling Toolkit

Onur Dulgeroglu, Systems Simulation Scientist, GE Global Research Center, 1 Research Circle, Niskayuna, NY, 12309, United States of America, dulgerog@research.ge.com, David Toledano

We will introduce a simulation based decision making toolkit designed by GE’s Global Research Center for GE Healthcare’s Performance Solutions business. The toolkit is applied alongside GE-HC’s advisory services over a wide spectrum of projects, ranging from long term strategic planning such as designing new hospitals, to short term proactive measures such as establishing real-time links with hospital IT systems to take realistic “snapshots” then fast-forward to avoid bottlenecks over the next day.

3 - The Impact of Workload on Hospital Reimbursement: Overworked Servers Generate Lower Income

Sergei Savin, Associate Professor, University of Pennsylvania, The Wharton School, Philadelphia, PA, 19104, United States of America, savin@wharton.upenn.edu, Nicos Savva, Adam Powell

We study the impact of physician workload on hospital reimbursement utilizing a detailed dataset from the trauma department of a major urban hospital. We find that the ratio of patients receiving a high severity status for reimbursement purposes, which maps to a 28% higher payment for the hospital, to substantially reduced as the workload of the discharging physician increases. This difference persists even after we control for a number of systematic differences in patients, treatment and time of discharge. Furthermore, we show the difference is not caused by selection bias or endogeneity in either discharge timing or discharge allocations. Finally, we find that the impact of workload on the probability that a patient is assigned a high severity is moderated by experience. We attribute this difference to a workload induced neglect of care in paperwork execution. We estimate the loss in revenue to be approximately 0.9% (with a 95% confidence interval of 0.3% and 1.5%) of the department’s annual revenue.
2 - Optimal Preventive Care Policies on Type 2 Diabetes Mellitus
Karca Aral, PhD Student, INSEAD. Technology & Operations Management Area, Boulevard de Constance, Fontainebleau, 77300, France, KarcaDuru.ARAL@insead.edu, Allons Grabosch, Stephen Chick

Type 2 Diabetes Mellitus (T2DM) is a common chronic condition that affects over 285 million people worldwide. The related global cost accounts for USD 326 billion in 2010 despite the fact that T2DM and its related complications are preventable through healthier lifestyle and dietary choices. In this study, we introduce a population level progression model of T2DM. We report on progress to our investigation on optimal preventive policies for resource allocation decisions regarding screening, public awareness and patient education programs for self-management around T2DM.

3 - Determining the Optimal Vaccine Subsidy: An OR Approach
Ruben Prono, Assistant Professor, Rochester Institute of Technology, 81 Lily Pond Memorial Drive, Rochester, NY, 14623, United States of America, rmpmeie@rit.edu, Wenbo Zhang

This study proposes an optimization-based approach to determine the minimum subsidy per vaccine dose that will make an expensive and currently non-affordable vaccine attractive for commercialization in a low-income market segment so that a desired number of children are immunized. The proposed optimization model minimizes across the vaccine market, the change in the total social surplus that is induced by the subsidy in the given low-income market segment.

TA04
04 - Fontaine Ballroom F
Integrating Patient Perspectives into Consumer and Clinical Decision-making
Cluster: Medical Decision Making
Invited Session
Chair: Jenna Marquard, University of Massachusetts Amherst, 219 ELab, 160 Governors Drive, Amherst, MA, 01003, United States of America, jimarquard@ecs.umass.edu

1 - Supporting Self-assessment in Healthcare through Exploration of Population-based Patient Data
Leigh Baumgart, University of Virginia, 151 Engineer’s Way, Charlottesville, VA, United States of America, lab3h@virginia.edu, Ellen Bass, Jason Lyman, John Voss

The task of making a self-assessment judgment, based on actual practice experience, is important in healthcare. Despite its importance, physicians have shown a limited ability to accurately self-assess. To address this need, an information analysis automation tool is currently under development to integrate and present population-based patient data to health care providers. Providing graphical reports and control over displayed information has aided in self-assessment judgments.

2 - Evaluating Decision-making in Clinical Encounters with Sequential Analysis
Jie Xu, University of Wisconsin-Madison, 3223 Mechanical Engineering Building, 1513 University Ave., Madison, WI, United States of America, jxu29@wisc.edu, Enid Montague

Training programs or technologies might affect doctor-patient communication, which is a critical aspect of shared decision making. In this study, a technique using video coding and lag sequential analysis was used to evaluate the eye gaze patterns in supplement of other verbal measures to evaluate patient participation in a clinical encounter.

3 - Nurses’ Behaviors and Eye Fixation Patterns in the Medication Administration Process
Jenna Marquard, University of Massachusetts Amherst, 219 ELab, 160 Governors Drive, Amherst, MA, 01003, United States of America, jimarquard@ecs.umass.edu, Ze He, Philip Henneman

This project aims to determine whether differences in nurses’ behaviors and eye fixation patterns during the medication administration process influence their capacities to recognize patient identification errors. Nurse participants who identified patient identification errors in a simulated setting tended to have a higher level of process efficiency, shorter non identification-related discussions, and more fragmented yet systematic eye fixation patterns than nurses who did not catch the error.
2 - First-line Family Physician Manpower Needs in Hospitals and the Health-care Network: The Essential Ingredient to Quality Care
Mark Roper, Director Division of Primary Care, McGill University Health Centre, 2100 Marlowe Avenue, Montreal, QC, H4A 3L5, Canada, mark.roper@mcgill.ca
The assessment of need in medical manpower is a complex and misunderstood process. The analysis of family medicine manpower and needs should be based on the best indicators available. A comprehensive analysis of variables affecting future need will also be discussed.

3 - The Improvement in the Average Length of Stay in a Community Hospital-The Broad Use of Lean Management Principles
Irwin Kuzmarov, Director of Professional and Hospital Services, Santa Cabrini Hospital, 5655 St. Zotique, Montreal, QC, H1T1P7, Canada, Irwin.Kuzmarov@ssss.gouv.qc.ca, Sandra Remer
The presentation will describe the entire operation and focus on the state maps both initial and “learn” model, as well as the thesepicyclic approach used both to evaluate and correct the patient production. The data over several periods will be presented.

■ TA07
07- Mont Royal
Healthcare Operations Management I
Sponsor: MSOM, Healthcare Operations Management
Sponsored Session
Chair: Bruce Golden, The France-Merrick Chair in Management Science Decision, Operations & Information Technologies, Robert H. Smith School of Business, University of Maryland, College Park, MD, 20742, United States of America, bgolden@rhsmith.umd.edu

1 - The Impact of Batching on Throughput and Flow Time in an Emergency Department
Gregory Dobson, Associate Professor, University of Rochester, Simon Graduate School of Business, Rochester, NY, United States of America, greg.dobson@simon.rochester.edu, Hsiao-hui Lee, Arvind Sainathan, Vera Tilton
In an ER at a teaching hospital we use queueing to analyze the patient exam by a resident, the subsequent conference with the attending, and the attending visit the patient and observe throughput and flow time of patients. We prove the throughput optimal policy, with preemptions. Without preemptions, we demonstrate numerically that a throughput optimal policy involves batching patients at the conference and resident waiting for the attending to start a conference. Constraining batch sizes or reducing the number of beds, reduces throughput slightly but has a large impact on flow time.

2 - Effects of Residents on Efficiency in an Emergency Department
David Anderson, University of Maryland, R.H. Smith School of Business, College Park, MD, United States of America, danderson@rhsmith.umd.edu, Bob Day, bday@business.uconn.edu, John Silberholz, Bruce Golden, Mike Harrington, Jon Mark Hirshon
The residency teaching model is often cited as a source of inefficiency in the healthcare system. We build a simulation model of an emergency department (ED) at a large urban academic hospital. Using historical data and a natural experiment involving residents in the ED, we show that residents in fact increase throughput and lower service and waiting times.

3 - A Dynamic Patient Network Model of Hospital-acquired Infections
Sean Barnes, University of Maryland, College Park, MD, United States of America, sbarnes@math.umd.edu, Bruce Golden, Edward Wasil
Hospital patients who share a healthcare worker are inherently connected to each other. These connections form a network through which transmission of infectious diseases can occur. The structure of this network is a strong determinant of the extent and rate of transmission. We examine how the density of this network and the behavior of healthcare workers, who often share patients and interact with each other, can affect transmission using a dynamic, agent-based model.

■ TA08
08- Hampstead
Optimal Resource Allocation
Cluster: Improving Patient Flow through Capacity Planning and Scheduling
Invited Session
Chair: Jonathan Patrick, University of Ottawa, Telfer School of Management, Ottawa, ON, Canada, patrick@telfer.uottawa.ca

1 - Effective ER Physician Scheduling to Balance Patient Service & Staffing Costs
Subhamoy Ganguly, University of Colorado at Boulder, 419 UCB, Boulder, CO, 80309, United States of America, subhamoy.ganguly@colorado.edu, Stephen Lawrence
Using historical patient arrival and service data, we develop an integral goal-programming model to provide an effective scheduling model for emergency rooms. A unique aspect of our approach is that we aggregate patient demand into discrete time buckets during a clinic day and model the stochastic distribution of aggregate patient demand within these buckets. This reduces the complexity of the ER scheduling problem without significantly reducing model fidelity. Our model helps balance staffing costs and service levels, and facilitates sensitivity analysis of different staffing policies.

2 - Mass-casualty Triage: Distribution of Victims to Multiple Hospitals using the SAVE Model
Matthew D. Dean, Assistant Professor, University of Southern Maine, School of Business, Portland, ME, United States of America, matthew.dean1@maine.edu, Suresh K. Nair
During a mass casualty incident (MCI), to which one of several area hospitals should each victim be sent? These decisions depend on resource availability (both transport and care) and the survival probabilities of patients. This paper focuses on the critical time period immediately following the onset of an MCI and is concerned with how to effectively evacuate victims to the different area hospitals in order to provide the greatest good to the greatest number of patients while not overwhelming any single hospital. This resource-constrained triage problem is formulated as a mixed-integer program. It is compared with a model in the extant literature and also against several current policies commonly used by the so-called incident commander. The experiments indicate that the proposed model provides a marked improvement over the commonly used ad-hoc policies. It also has an average improvement of 36.5% and 69.0% in the expected number of survivors over the existing model, depending on how it is implemented. A discussion surrounding the circumstances in which it would be advantageous to have more transport resources available versus more hospital capacity provides guidelines for implementation of the proposed model to incident commanders of mass casualty incidents.

3 - Sharing the Blocks: A Win-win Strategy for Surgeons and Hospital Operation Room Utilization
Robert Day, Assistant Professor, University of Connecticut, School of Business, Storrs, CT, 06269, United States of America, Bob.day@business.uconn.edu, Robert Garfinkel, Steven Thompson
We develop a mechanism that enables hospitals to allocate surgical block time to physicians that improves OR suite utilization while maintaining or improving accessibility. Implementation results at a local hospital show that the mechanism is effective.

■ TA09
09- Cote St. Luc
Disease Modeling
Cluster: Pharmacoeconomics
Invited Session
Chair: Lauren Cipriano, Stanford University, Dept. of Management Science & Engineering, Huang Engineering Center, Stanford, CA, United States of America, cipriano@stanford.edu

1 - Incorporating New Evidence into an Existing Microsimulation Model: A Case Study
Pamela McMahon, Associate Director, MGH Institute for Technology Assessment, 101 Merrimac St., Boston, MA, United States of America, pamela@mgh-hta.org, Kathryn Lowry, G. Scott Gazelle, Chung Yin Kong
We describe how we approach current clinical questions by incorporating new data into an existing microsimulation model, the Lung Cancer Policy Model (LCPM), previously used to evaluate lung cancer screening programs and tobacco control. The model is one of a group of lung cancer models in the NCI’s Cancer Intervention and Surveillance Modeling Network (CISNET) consortium that will be used to interpret and extend findings from the National Lung Screening Trial.
2 - Cost-effectiveness of a 21-gene Recurrence Score Assay for Breast Cancer using Administrative Data
Malek Basam Hannouf, PhD, University of Western Ontario, Schulich School of Medicine & Dentistry, London, ON, NSX 2N4, Canada, Malek.Bassam@schulich.uwo.ca, Bin Xie, Muriel Brackstone, Greg Zaric

We developed a Markov model to evaluate the cost effectiveness of a 21-gene recurrence score assay versus current Canadian clinical practice in women with early stage breast cancer. The model was parameterized using 7 year follow up data from the Manitoba Cancer Registry and cost data from the Manitoba Health and Healthy Living.

3 - Applying Multi-objective Optimization to Cancer Screening Models
Chung Yin Kong, Senior Scientist, Massachusetts General Hospital, 101 Merrittac St., 10th FL, Boston, MA, 02114, United States of America, joey@mgh-it.org, Pamela McMahon, G. Scott Gazelle, Jannie Lee

Simulation modeling has become an important tool in the economic and policy evaluation of cancer prevention and control. To ensure the accuracy of the model’s predictive ability, a disease simulation model must calibrate to the existing clinical and epidemiologic data. In this study, we applied a Pareto optimal frontier method to calibrate disease simulation models with multiple calibration targets. The Pareto optimal frontier method creates a repository of optimal model parameters which allows users to select the most suitable solution(s) for their applications.

# TA10
10 - Westminster
Models in Organ Transplantation
Cluster: Transplant Operations
Invited Session
Chair: Stefanos Zenios, Charles A. Holloway Professor, Stanford University, Graduate School of Business, 518 Memorial Way, Stanford, CA, 94305-5015, United States of America, stefzen@gsb.stanford.edu

1 - OrganJet: Overcoming Geographical Disparities in Access to Deceased Donor Kidneys
Baris Ata, Northwestern University, 2001 Sheridan Road, Evanston, IL, United States of America, b-ata@kellogg.northwestern.edu, Sridhar Tayur, Anton Skaro

There are over 80,000 patients in the US waiting for a kidney transplant. Under the current allocation policy, deceased organs are first allocated locally. This causes significant disparities across different geographical regions. We propose an operational solution that offers affordable jet services (OrganJet) to patients on the transplant waiting list, which allows them to multiple-list in different locations (OPDs) of their choosing. OrganJet helps remedy current disparities provided a small fraction choose to multiple-list, resulting in uniform waiting times to transplant in the US.

2 - Ontology and Decision Tree Approaches to understand Attribute Relations in Bone Marrow Transplants
Pouya Raeiszadeh, University of Toronto, 5 King’s College Road, Room 304, Toronto, ON, Canada, praeire@utoronto.ca, Dionne Aleman, Arshdeh Ghavamzadeh

Bone marrow transplantation (BMT) is commonly used to treat patients with cancer and immunodeficiency diseases. Several criteria should be considered when choosing a BMT donor. We present an ontology approach to provide an unambiguous understanding of the BMT donor selection process, and a decision tree approach to explore the significance of these criteria on patient survival.

3 - Recipient Choice in a Scoring-based Kidney Allocation Policy
Yichuan Ding, Stanford University, 14 Comstock Circle, Apt 106, Stanford, CA, 94305, United States of America, y7ding@stanford.edu, Stefanos Zenios

This article studies typical scoring-based kidney allocation policies, and the related problems about patients’ incentive in accepting/rejecting a kidney. We derive an incentive compatible condition under which the new scoring system proposed in the RFI can potentially encourage patients to accept kidneys at an earlier time. Our research was the first attempt to analytically model the waitlist under a scoring-based policy. Our results may not be obtained from simulation tests.

# TA11
11 - Outremont
Healthcare-Product Supply-Chain Management I
Sponsor: MSOM, Healthcare Operations Management
Sponsored Session
Chair: Leroy Schwarz, Louis A. Weil, Jr., Professor of Management, Purdue University, Krannert School, 401 W State Street, West Lafayette, IN, 47907, United States of America, lschwarz@purdue.edu

1 - Supply Chains and Surgical Suite Performance
Vicki Smith-Daniels, Professor, Arizona State University, Tempe, AZ, United States of America, Vicki.Smith-Daniels@asu.edu

Drawing on coordinating mechanisms research, this study examines the effects of supply chain coordination on surgical suite operational performance, as well as the complementary performance effects of integrated information systems capability on inter-functional and inter-organizational supply chain coordination. Operational performance has been conceptualized as a composite construct made up of several performance indicators.

2 - Centralized Distribution Strategies in Healthcare
Sylvain Landry, Professor PhD, HEC Montréal, Montreal, QC, Canada, sylvain.landry@hec.ca, Jacques Roy, Martin Beaulieu

For some 15 years, North America has been witness to a movement to better integrate and consolidate local and regional logistics resources. However, this movement has not produced a single solution. A variety of factors must be considered in order to succeed in this type of initiative: leadership, governance, performance measurement, internal logistics expertise or access to external expertise, recruitment, risk management and financial factors, IT platform, change management, and more. This presentation will examine a number of centralized distribution models and strategies.

3 - The Impact of Group Purchasing Organizations on Healthcare-product Supply Chains
Leroy Schwarz, Louis A. Weil, Jr., Professor of Management, Purdue University, Krannert School, 401 W State Street, West Lafayette, IN, 47907, United States of America, lschwarz@purdue.edu, Joice Hu, Nelson Uhan

This paper examines the impact of group purchasing organizations (GPOs) on healthcare-product supply chains. The supply chain we examine consists of a profit-maximizing manufacturer with a quantity-discount schedule that is nonincreasing in quantity and ensures nondiminishing revenue, a profit-maximizing GPO, a competitive source selling at a fixed unit price, and n providers (e.g., hospitals) with fixed demands for a single product. Each provider seeks to minimize its total purchasing cost (i.e., the cost of the goods plus the provider’s own fixed transaction cost). Buying through the GPO provides possible cost reductions, but may involve a membership fee. Selling through the GPO provides the manufacturer possibly higher volumes, but requires that the manufacturer pay the GPO a contract administration fee (CAF): i.e., a percentage of all revenue contracted through it. Using a game-theoretic model, we examine questions about this supply chain, including how the presence of a GPO affects the providers’ total purchasing costs. We also address the controversy about whether Congress should amend the Social Security Act, which, under current law, permits CAFs. Among other things, we conclude that although CAFs affect the distribution of profits between manufacturers and GPOs, they do not affect the providers’ total purchasing costs.

# TA12
12 - Verdun
Optimization of Radiation Therapy Treatment Plans
Sponsor: INFORMS Health Applications Section
Sponsored Session
Chair: Edwin Romeijn, Professor, University of Michigan, IOE Department, 1205 Beal Avenue, Ann Arbor, MI, 48109-2117, United States of America, romeijn@umich.edu

1 - Handling of Conflicting Goals and Uncertainty in External Beam Therapy
Anders Forsgren, KTH Royal Institute of Technology, Stockholm, SE-100 44, Sweden, anders@kth.se, Rasmus Bokrantz, Albin Fredriksson, Bjorn Hardemark

We consider two fundamental problems arising in external beam therapy. The first is the problem of efficiently approximating the set of Pareto optimal solutions arising in multi-criteria intensity-modulated radiation therapy. We describe a dual sandwich method for approximating the Pareto set. The second problem is the handling of uncertainty in intensity-modulated proton therapy by robust optimization. We describe a method for handling uncertainty in range and setup.
2 - Dynamic Robust Optimization for Fractionated IMRT Treatment Planning
Velibor Misic, University of Toronto, Toronto, ON, Canada, velibor.misic@utoronto.ca, Timothy C. Y. Chan
The traditional approach to robust IMRT treatment planning involves defining an uncertainty set, solving a single planning problem and using the solution in all treatment sessions. In this talk, we describe a dynamic robust optimization approach to IMRT treatment planning, where information gathered in each treatment session is used to update the uncertainty set and improve subsequent treatment sessions. We present computational results for a lung cancer patient case and show that this method significantly improves upon the non-dynamic robust approach in both tumor coverage and organ sparing.

3 - Sensitivity Analysis for Lexicographic Optimization in Radiation Therapy Treatment Planning
Troy Long, University of Michigan, 1745 Broadway Ln., Apt 510, Ann Arbor, MI, 48105, United States of America, troylong@umich.edu, Edwin Romeijn.
We study the problem of quantifying clinically relevant tradeoffs between and within different stages in lexicographic optimization for IMRT treatment planning. We propose methods to identify and construct Pareto Frontiers that coherently present beneficial information to physicians. We apply our approach to a clinical case of prostate cancer.

**Panel Session: Emerging Teaching and Degree Options in Healthcare Systems Engineering**
Chair: David Lane, Reader in Management Science, London School of Economics, LSE NAB 3.33, Houghton Street, London, WC2A 2AE, United Kingdom, d.c.lane@lse.ac.uk

1 - A Multi-method Equation-based Approach for Healthcare Modeling
Jim Duggan, NUI Galway, University Road, Galway, Ireland, jim.duggan@nuigalway.ie
System Dynamics (SD) and Agent-Based Modelling (ABM) are particularly effective modelling methods for gaining insight into the dynamics of disease transmission. Both approaches differ in terms of their underlying worldview and technical constrains. In domains such as epidemiology, ABM code-based models can often lack the transparency of equation-based models. This model building approach proposes an integrated framework for SD and ABM, based solely on mathematical equations. A case study is presented, and possible healthcare applications discussed.

2 - An Ontology Modeling to Enhance Clinical Diagnosis Process Via Patient-Physician GTP Communication
Zahra Maslavi, Tarbiat Modares University, Jalal-e Al-e Ahmad Highway, Tehran, Iran, zahra_paint@yahoo.com, Mohammad Mehdi Sepehri
Clinical diagnosis is usually affected by two types of problems. First, inaccurate diagnosis which is often the result of an incomplete transformation of necessary information by the patient to the physician and second is the waste of time that is due to assertion of unnecessary information by the patient that leads to increasing the waiting time for other patients. In this paper we suggest a more profound solution for these two problems in the context of an ontology-based questionnaire system which helps the physician to “get to the point” (GTP) communication.

3 - Clostridium Difficile: System Dynamics Modeling of Hospital Infection Outbreaks
David Lane, Reader in Management Science, London School of Economics, LSE NAB 3.33, Houghton Street, London, WC2A 2AE, United Kingdom, d.c.lane@lse.ac.uk
London School of Economics and UK National Audit Office staff constructed a simulation model to understand and control Clostridium difficile outbreaks. Different contamination stages, various transmission mechanisms and bed, toilet and staff hand cleaning were represented. The model synthesises information from a range of sources. It allows users to understand the consequences of the interaction of a number of transmission vectors and to explore policy interventions aimed at combating outbreaks.

Tuesday, 10:30am - 12:00pm

**TB01**

01 - Fontaine Ballroom C
Panel Session: Emerging Teaching and Degree Options in Healthcare Systems Engineering
Cluster: Invited Sessions
Invited Session
Chair: Nebil Buyurgan, Associate Professor, University of Arkansas, 4207 Bell Engineering, Fayetteville, AR, 72701, United States of America, nebilb@uark.edu

1 - Healthcare Systems Engineering Education Programs
Moderator: Nebil Buyurgan, Associate Professor, University of Arkansas, 4207 Bell Engineering, Fayetteville, AR, 72701, United States of America, nebilb@uark.edu, Panelists: Oguzhan Alagoz, Julie Swann, Steve Roberts, Hisham Abu-Nabaa

2 - Dynamic Robust Optimization for Fractionated IMRT Treatment Planning
Velibor Misic, University of Toronto, Toronto, ON, Canada, velibor.misic@utoronto.ca, Timothy C. Y. Chan

3 - Sensitivity Analysis for Lexicographic Optimization in Radiation Therapy Treatment Planning
Troy Long, University of Michigan, 1745 Broadway Ln., Apt 510, Ann Arbor, MI, 48105, United States of America, troylong@umich.edu, Edwin Romeijn.

**TB02**

02 - Fontaine Ballroom D
Quantitative Decision Making in Long Term Care
Sponsor: INFORMS Health Applications Section
Sponsored Session
Chair: Nan Kong, Assistant Professor, Purdue University, 206 S. Martin Jischke Dr., West Lafayette, IN, United States of America, nkong@purdue.edu

1 - Investment Reaction Model
Ali Vahid Esensoy, PhD Student, University of Toronto, 5 King's College Road, Toronto, ON, M5S 3G8, Canada, ali.esensoy@utoronto.ca, Michael Carter
This work involves the development of a system dynamics simulation model of a Local Health Integration Network to assess the effects of major investments into seniors’ home and community care services on patient flows between health system sectors. Primary focus of the model is to determine the extent to which hospital discharge rates to home and long-term care, and emergency department use were influenced by Ontario’s $1.1bn Aging At Home Strategy.

2 - Optimal Financing Structure Design for Traumatic Brain Injury (TBI) Patients
Zhen Zhu, Purdue University, West Lafayette, IN, United States of America, zzh@purdue.edu, Andrew Liu, Nan Kong
While it is unfair to blame the high healthcare expenditure in the U.S. on the lack of a universal healthcare system, it would be important to examine the structure cost which does not contribute to the wellness of the patients and study new financing structures that minimize such cost. In this paper, we establish a leader-follower game involving two players, public and private insurers to study three types of structure costs (i.e. administration, over-insurance and moral hazard cost) for a potential TBI cohort. An optimal financing scheme is proposed.

3 - Planning Long Term Care Capacity with Complex Patient Pathways for the Fraser Health Authority
Yurik Sandino, STT/Managing Consultant-Ops Engineering, Fraser Health Authority, 5th Floor, 625 Agnes Street, New Westminster, BC, V3M 5V4, Canada, yurik.sandino@fraserrhealth.ca, Eduardo Garza, Tim Lane, Derek Atkins
The Fraser Health Authority provides services for over 1.5 million residents across the continuum of care. In order to inform Residential Care (RC) capacity planning efforts, its leadership team was interested in developing a ‘desktop’ decision support tool that would allow the quick analysis of various capacity configurations for existing and possibly new services and/or different patient pathways. This was achieved through collaboration between the Operations Engineering and RC groups at FHA and the Centre for Operations Excellence (COE) at the Sauder School of Business, UBC.
Improving healthcare delivery requires operational changes in the processes of care provision and in the supply chain for delivering key healthcare inputs. Operations management researchers have used a combination of analytical models and empirical approaches to answer key design questions in healthcare service delivery. We often find that well tested operational designs sometimes fail or lose their cost efficiency benefits when transferred to a developing country setting. Lack of data and inability to make the right modeling assumptions for a very different socio-economic setting requires a new “implementation science” toolkit for developing country healthcare care that is built on field observation and can be understood, used and accepted by researchers in medicine, engineering, and business. Although randomized, controlled experiments are the gold standard for testing safety and efficacy of pharmaceuticals and other healthcare interventions, they have not been widely used for operational design problems in healthcare. Using examples of randomized experiments from Zambia and Tanzania, this tutorial will provide an overview of the research tools and pragmatic issues in conducting large scale randomized experiments in healthcare operations management.

## TB04

### 04- Fontaine Ballroom F

#### Population Analysis for Individualized Medical Decision Support

**Cluster:** Medical Decision Making  
**Invited Session**

**Chair:** Jianying Hu, IBM T. J. Watson Research Center, 19 Skyline Drive, Hawthorne, NY, 10532, United States of America, jhy@us.ibm.com

1 - Supervised Patient Similarity of Heterogeneous Patient Records  
Jimeng Sun, IBM TJ Watson Research Center, Healthcare Transformation, NY, United States of America, jJimeng@us.ibm.com, Jianying Hu, Shahram Ebadolahi, Fei Wang  
Due to the growing use of Electronic Health Records (EHR), various sources of information become available about patients. A key challenge is to identify the appropriate and effective secondary uses of EHR data for improving patient outcome without incurring additional effort from physicians. To achieve the goal of the meaningful use of EHR data, patient similarity becomes an important concept. The objective of patient similarity is to derive a similarity measure between a pair of patients based on their EHR data. With right patient similarity in place, many applications can be enabled: 1) case-based retrieval of similar patients for a target patient; 2) treatment comparison among the cohort of similar patients to a target patient; 3) cohort comparison and comparative effectiveness research. One of the key challenges to derive meaningful similarity measure is how to leverage physician input. In this work, we present a set of approaches about how to encode physician input as supervised information to guide the similarity measure to address the following questions: 1) How to adjust the similarity measure according to physician feedback? 2) How to combine different similarity measures from multiple physicians? 3) How to interactively update the existing similarity measure efficiently based on new feedback?

2 - Identifying Patients at Risk: Methods and Application  
Michal Ozery-Plato, Research Staff Member, IBM Research, Mount Carmel, Haifa, 31905, Israel, ozery@il.ibm.com, Hani Neuvirth, Jonathan Laserson, Michal Rosen-Zvi, Jianying Hu, Martin S. Kohn, Shahram Ebadolahi  
Currently, healthcare data management systems record vast amounts of information about patients. We analyze this information and develop a model for identifying chronic patients at risk for disease aggravation. For this purpose, we explore the use of various classic machine learning techniques and common statistical methods to achieve the most accurate assessment of the risk. Finally, we demonstrate an application of this model for improving care delivery.

3 - Representing Concurrent Clinical Practice Guidelines as a CLP Model  
Martin Michalowski, Adventium Labs, 111 Third Ave. S, Suite 100, Minneapolis, MN, 55401, United States of America, martin.michalowski@adventiumlabs.org, Marisela Mainegra Hing, Wojtek Michalowski, Szymon Wilk, Ken Fariot  
This talk describes a novel methodological approach to identifying inconsistencies when combining multiple clinical practice guidelines. The need to address these inconsistencies arises when a patient with co-morbidity (i.e. multiple diseases affecting multiple body systems) has to be managed according to different treatment regimens. We discuss how to represent a formal guideline model using Constraint Logic Programming (CLP), chosen for its ability to handle relationships between patient’s state, diagnosis, and treatments. We present methods to identify conflicting actions that are manifested by treatment-treatment and treatment-disease interactions that are associated with co-morbidity. Using an open source constraint programming system (ECLiPSe), we demonstrate our approach’s ability to identify medically contradictory actions and to present them to a physician for use in generating treatment plans. We apply our approach to various scenarios where a patient has concurrently asthma exacerbation and a peptic ulcer, correctly identifying inconsistencies and finding valid solutions when present.
1 - Optimal Booking Strategies for Outpatient Procedure Centers

Bjorn Berg, North Carolina State University, Raleigh, NC, 27607, USA, bjberg@ncsu.edu, Brian Denton, S. Ayca Erdogan, Thomas Rohleder, Todd Huschka

Patient appointment booking, sequencing, and scheduling decisions are challenging for outpatient procedure centers due to uncertainty in patient appointment times and patient attendance. We formulate a model based on a two-stage stochastic mixed-integer program for optimizing booking and appointment times in the presence of uncertainty. Analytical insights are reported for special cases and experimental results show that they provide useful rules of thumb for more general problems. A case study based on an endoscopy suite is used to draw useful insights for procedure center managers.

2 - An Assessment of Six Sigma in Healthcare Delivery

Matthew Liberatore, Director, Analytics Strategic Initiative Group, John F. Connelly Chair in Management, Department of Management and Operations, Villanova University School of Business, Villanova University, Villanova, PA, United States of America, Matthew.liberatore@villanova.edu

This paper reviews and assesses the extant literature on the application of six sigma in healthcare delivery, focusing on the areas of application, process changes initiated and outcomes, including improvements in process metrics, cost, and revenue. The findings suggest that although six sigma has been effective in improving healthcare delivery, more emphasis needs to be placed on improving the process of identifying and evaluating alternatives, and verifying that the changes implemented offer significant and sustainable improvements.

3 - Dynamic Multi-appointment Patient Scheduling for Radiation Therapy

Antoine Sauré, PhD Student, Sauder School of Business, University of British Columbia, 2053 Main Mall, Vancouver, BC, V6T 2Z2, Canada, antoine.sauere@sauder.ubc.ca, Martin Puterman

Seeking to reduce the potential impact of delays on radiation therapy cancer patients such as psychological distress, deterioration in quality of life and increased cancer control and survival, and motivated by inefficiencies in the use of expensive resources, we formulate and solve a discounted infinite-horizon Markov decision process for scheduling treatments in radiation therapy units. The main purpose of this model is to identify good policies for allocating available treatment capacity to incoming demand, while reducing wait times in a cost-effective manner.
Decision makers responsible for HIV resource allocation have little guidance and can benefit significantly from practical models that can inform the process. We developed the REACH (Resource Allocation for Control of HIV) model, a customizable user-friendly tool that can perform portfolio analyses and recommend optimal resource allocations to control HIV. We performed example analyses in three settings (Ukraine, Ukraine, and St. Petersburg, Russia).

2 - The Cost-effectiveness of Pre-exposure Prophylaxis Among Men who have Sex with Men
Robert Koppenhaver, Centers for Disease Control and Prevention, Corporate Square, Atlanta, GA, 30329, United States of America, RKoppenhaver@cdc.gov, Stephen Sorensen, Stephanie Sansom
Pre-exposure Prophylaxis (PrEP) has been shown to reduce HIV incidence among men who have sex with men (MSM) according to a recent study. While PrEP's efficacy has been demonstrated, its cost-effectiveness remains unknown. Given the high cost of PrEP, it is unclear whether or not public health dollars should be invested in PrEP programs. We have developed an epidemic model of HIV among a population of MSM. We compare the cost-effectiveness of current practice (testing, antiretroviral treatment, etc.) to scenarios in which some or all MSM are given PrEP.

3 - Cost Effectiveness of Screening for HIV and HCV Infection in Injection Drug Users
Lauren Cipriano, Stanford University, Dept. of Management Sciences, Engineering, Huang Engineering Center, Stanford, CA, United States of America, cipriano@stanford.edu

The injection drug user (IDU) population continues to experience epidemic rates of new HIV and hepatitis C (HCV) infections. Detection of new infections during the acute phases of these diseases may provide an opportunity to improve patient outcomes and change the course of these epidemics. We aimed to compare the effectiveness and cost-effectiveness of various screening protocols and frequencies of screening for acute and chronic HIV and HCV infection among IDUs in opioid replacement therapy (ORT) using a dynamic compartmental model of the HIV and HCV co-epidemic.

Organ Transplant Models
Cluster: Transplant Operations
Invited Session
Chair: Steven Shechter, University of British Columbia, 2053 Main Mall, Vancouver, Canada, steven.shechter@sauder.ubc.ca

1 - A Self-promoting Priority Model for Transplant Queues
Steve Drekic, Associate Professor, Dept. of Statistics & Actuarial Sciences, University of Waterloo, Waterloo, ON, N2L 3G1, Canada, sdrekic@math.uwaterloo.ca, David Stanford, Douglas Woolford

In many jurisdictions, organ allocation is done on the basis of the health status of the patient, either explicitly or implicitly. This presentation presents a self-promoting priority model which takes into account changes in health status over time. In the first variant, all patients arrive as "regular" customers to the queue, promoting priority model which takes into account changes in health status over the patient, either explicitly or implicitly. This presentation presents a self-promoting priority model that can perform portfolio analyses and recommend optimal resource allocations to control HIV. We performed example analyses in three settings (Ukraine, Ukraine, and St. Petersburg, Russia).

2 - Fairness, Efficiency and Flexibility in Renal Transplantation
Nikolaos Trichakis, Massachusetts Institute of Technology, 77 Massachusetts Avenue, Building E40-133, Cambridge, MA, 02139, United States of America, nitriechakis@mikos.mit.edu, Dimitris Bertsimas, Vivek Farias

The allocation of deceased-donor kidneys to patients on waitlists is carried out by ranking them according to a point system. We propose a method for designing point systems that allows policymakers to balance efficiency and fairness, taking as input fairness constraints from a broad class of allowable constraints. Using the method, we design a point system that has the same fairness properties and achieves an 8% increase in life-years gained relative to the one currently proposed by policymakers. Performance is evaluated using the same data and simulation tools as the policymakers use.

3 - Optimal Screening Strategies of Patients on the Kidney Transplant Waiting List
Alireza Sabouri, University of British Columbia, Vancouver, BC, Canada, alireza.sabouri@sauder.ubc.ca, Steven Shechter, Tim Huh

The health condition of patients on the kidney transplant waiting list deteriorates while they are waiting for an organ arrival and hence they may no longer be suitable for transplant. Therefore, transplant centers screen patients at various intervals to identify ineligible patients. We propose a model for finding screening strategies that minimizes the expected screening cost and the expected penalty cost associated with transplanting an organ to an ineligible patient.

Healthcare-Product Supply-Chain Management II
Sponsor: MSOM, Healthcare Operations Management
Sponsored Session
Chair: Leroy Schwartz, Louis A. Weil, Jr., Professor of Management, Purdue University, Krannert School, 401 W State Street, West Lafayette, IN, 47907, United States of America, lswartz@purdue.edu

1 - A Scenario Planning Process to Prepare U.S. Healthcare System for an Uncertain and Different Future
Sharul Phadnis, Massachusetts Institute of Technology, Cambridge, MA, United States of America, sharul@mit.edu, Mahender Singh, Yossi Sheffi

The US healthcare sector is witnessing fundamental shifts on the demand side (focus on chronic care, home care, etc.), supply side (shift from blockbuster drugs to generic and biologic), and in regulations (pedigree, drug diversion, etc.). This will change the healthcare sector dramatically, but how and how fast it will change is unpredictable. One method to prepare for an unpredictable future is scenario planning. In this paper, we describe the findings from an action research study of developing the supply chain strategy for a firm in the US healthcare sector by creating and using scenarios.

2 - Meaningful Use of Information Technologies in the Health Care Supply Chain: An Empirical Analysis
Kingshuk Sinha, University of Minnesota, Minneapolis, MN, United States of America, kingshuk@umn.edu, Asoke Dey, Sriram Thirumarai

An array of information technologies available today promises to improve the performance of organizations and the supply chains within which they are embedded. However, the "meaningful use" of technologies requires an understanding of how organizations select the appropriate technologies, how they develop their technology capability, and leverage such capability to realize performance gains. This paper is an attempt to shed light on issues related to meaningful use of health information technologies. The empirical setting of this research is the health care supply chain and the technology capability of interest is the electronic medical record (EMR) capability of health care providers-i.e., the ability to acquire, deploy, and leverage health information technologies to enable and link the clinical processes and support decision-making for effective delivery of care. In recent years, there has been a proliferation of health information technologies that promise to improve the delivery of care. However, health care providers often find the development of EMR capability and the subsequent realization of the concomitant benefits to be challenging. To that end, this research builds on the recent literature to identify and conceptualize the various stages of EMR capability development. Based on a synthesis of the relevant theoretical perspectives, we post hypotheses that (i) relate the stages of EMR capability to the operational performance of health care providers, (ii) relate the choice of the stage of EMR capability to the technological, organizational, and environmental (TOE) factors of health care providers; and (iii) highlight the implications of selection into a stage of EMR capability by health care providers. The empirical analysis in the study is based on data from 101 acute care providers in the U.S. The study findings indicate that the operational performance of health care providers, measured as discharges per licensed bed, is positively related to the stage of EMR capability. We find that the choice of the stage of EMR capability is significantly influenced by the TOE factors of a provider. Further, the study findings indicate that while operational performance may be higher at higher stages of EMR capability, some providers nevertheless select into the lower stages, i.e., providers systematically self-select into different stages of EMR capability. Contrary to expectations, we find that when health care providers are assigned to a higher stage of EMR capability (that is not self-selected), they fail to realize the potential operational performance benefits of that stage of EMR capability. Implications of the study findings, contributions, and directions for future research are identified.
3 - The Diffusion of Supply Chain Information Technology in U.S. Hospitals and Hospital Systems
Bushra Rahman, Research Administrator, Arizona State University, 519 W. Ecinas St., Gilbert, AZ, 85233, United States of America, Bushra.Rahman@asu.edu, Eugene Schneller, Michael Furukawa
This research scrutinizes HIMMS data to better understand the diffusion of supply chain technology in U.S. hospitals and hospital systems. We consider key variables including the centralization of governance, hospital size, system ownership, system age, geographical location and hospital surgical intensity. Technologies considered include both supply chain and other technologies.

TB12
12 - Verdun
Successful OR Applications in Inpatient Healthcare
Sponsor: INFORMS Health Applications Section
Sponsored Session
Chair: Murray Côté, Associate Professor, Texas AM Health Science Center, Health Policy & Management, School of Rural Public Health, College Station, TX, 77843, United States of America, cote@sph.tamhsc.edu
1 - Decreasing Environmental Services Response Times
Murray Côté, Associate Professor, Texas AM Health Science Center, Health Policy & Management, School of Rural Public Health, College Station, TX, 77843, United States of America, cote@sph.tamhsc.edu, Zach Robison
In order to enhance throughput and patient flow at University of Colorado Hospital, a statistical staffing model for environmental services was developed. The model, which balances appropriate staffing levels to predicted staffing levels, resulted in significant decreases in response time without compromising quality, safety, or costing additional resources.

2 - A Plea for Help from an ED Physician
David Eitel, Wellspan Health System, 1001 South George St., York, PA, United States of America, davelite@comcast.net
The need for operations research is even more critical in today’s healthcare environment, especially the emergency department. This talk will review the state of affairs in the ED, contrast the reality of this industry with its assumptions, and conclude with suggestions on how to better engage OR/MS professionals.

3 - Multi-Project “Learning” in a Complex University and Health Organizations Research Environment
Nick Edwardson, Assistant Director, Texas AM Health Science Center, College Station, TX, United States of America, edwardson@sph.tamhsc.edu, Larry Gamm
This presentation addresses opportunities in the context of multi-project work of the Texas AM Health Science Center’s (TAMHSC) Center for Health Organization Transformation, an NSF-funded Industry/University Cooperative Research Center. TAMHSC is joined by 3 university partners and works with multiple health system members. Currently, TAMHSC researchers are working with 6 health systems on different, but related projects. This presentation relies on organizational technologies framework to describe the multi-project learning opportunities emerging within this unique learning environment.

TB13
13 - Lachine
Applications of M&S in Healthcare Management
Sponsor: INFORMS Simulation Society
Sponsored Session
Chair: Rafael Diaz, Research Assistant Professor, Old Dominion University / VMASC, 1030 University Blvd., Suffolk, VA, 23435, United States of America, RDiaz@odu.edu
1 - A System Dynamics Model for Testing Healthcare Interventions Targeting Treatment Utilization
Joshua G. Behr, Associate Professor, Old Dominion University/VMASC, 1030 University Blvd., Suffolk, VA, 23435, United States of America, jbehr@odu.edu
A System Dynamics approach is employed to capture the complexity of patient flow among treatment venues within the US healthcare system. This project investigates changes in system behavior stemming from deployed interventions as well as interventions that have been developed theoretically but not yet implemented. These efforts lead us to understand the dynamic demand-capacity behavior of the health system over time and empirically demonstrate changes in the behavior of the system that are counterintuitive or would not have been evident if approached with more traditional causal methodologies.

TC01
01- Fontaine Ballroom C
Models for Healthcare System Improvement - Part I
Cluster: Invited Sessions
Invited Session
Chair: Harriet Black Nembhard, Pennsylvania State University, University Park, PA, United States of America, hbn2@engr.psu.edu
1 - New Models for Emergency Department Management
Marc Alfaiolo, ED Director, Jewish General Hospital, Montreal, QC, Canada
In this presentation, new conceptual models for ED management will be reviewed. The talk will include: vertical and horizontal patients sections, ultra fast-track and RAZ, ultra rapid triage and MD in triage. Research work using simulation will be presented and linked to value stream mapping of ED processes.

TB12
12 - Verdun
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Sponsor: INFORMS Health Applications Section
Sponsored Session
Chair: Murray Côté, Associate Professor, Texas AM Health Science Center, Health Policy & Management, School of Rural Public Health, College Station, TX, 77843, United States of America, cote@sph.tamhsc.edu
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TC02
02- Fontaine Ballroom D
Efficient Delivery of Home Health Care
Sponsor: IE, Society for Health Systems
Sponsored Session
Chair: Ashlea Bennett, Assistant Professor, University of Arkansas, 4207 Bell Engineering Center, Fayetteville, AR, 72701, United States of America, ashlea@uark.edu
1 - Home Health Care Scheduling and Routing
Mike Hewitt, Rochester Institute of Technology, 81 Lomb Memorial Drive, Rochester, NY, 14534, United States of America, mrhewie@rit.edu, Mackie Nowak, Ashlea Bennett
The success of home health care, in terms of savings and health outcomes, has led to a dramatic increase in use. This increase, combined with cuts in government funding, has stretched resources thin. Thus, the efficiency in how home health care providers are used to care for patients is vital. However, consistency with respect to the nurse and time of day associated with a patient visit can be just as important as efficiency. We conduct a qualitative study of the impact of these consistency metrics, and propose an algorithm for producing schedules and routes that considers all objectives concurrently.
2 - Patient Assignment to Nurses in Homecare Delivery
Nadia Lahrichi, Sr Mortimer B. Davis Jewish General Hospital, 3755 Chemin de la Côte-des-Neiges, Montreal, H3T 1E2, Canada, nadia.lahrichi@cirrell.ca
We approach assigning patients to nurses in homecare by distributing and balancing the workload among nurses. We propose a new approach combining territorial approach and workload measure to better achieve nurses' satisfaction. We model the problem as a multi-resource generalized assignment problem where the objective is to minimize the gap between workloads.

3 - Estimating the Value of Remote Health Monitoring Systems
Ashlea Bennett, Assistant Professor, University of Arkansas, 4207 Bell Engineering Center, Fayetteville, AR, 72701, United States of America, ashlea@uark.edu
Caring for patients with chronic illnesses accounts for 75% of U.S. healthcare spending. Technological advances in remote monitoring systems may provide a more cost-effective and less labor-intensive way to manage the care of patients with chronic illnesses by focusing on preventive measures and continuous monitoring instead of emergency care and hospital admissions. We develop a model that estimates the value of providing remote monitoring devices to chronically ill persons. The model considers how capacity constraints and fairness concerns should impact device allocation to target populations. A computational study is presented for a subset of the most common chronic diseases.

TC03
03- Fontaine Ballroom E
Improving Public Health Supply Chains in Low Income Countries
Cluster: Invited Sessions
Invited Session
Chair: Prashant Yadav, MIT-Zaragoza International Logistics Program, Zaragoza Logistics Center, Zaragoza, MA, Spain, pyadav@mit.edu
1 - Improvements to the Public Distribution of Essential Medicines in Africa: The Case of Zambia
Ngai-Hang Leung, Massachusetts Institute of Technology, 77 Massachusetts Avenue Bldg. E40-149, Cambridge, MA, 02139, United States of America, zacleung@mit.edu, Anastasia Chen, Jérémie Gallien, Romain Davrouch, Prashant Yadav
Remarkable and successful recent improvements efforts by the government and its partners have improved the access to essential drugs in Zambia. However, through changes in the inventory control system the improved public distribution system could still be enhanced to reach higher standards of availability. We present a possible alternative system design involving mobile devices and optimization and evaluate this proposal via a simulation model built with field data. Our results suggest that this proposal would improve drug availability at the clinics and reduce inventory and drug expiry costs.

2 - Decentralization of Resource-limited Health Care Networks: Optimal Placement of Diagnostic Devices
Sarang Deo, Northwestern University, 2145 Sheridan Road, Evanston, IL, 60208, United States of America, s-deo@kellogg.northwestern.edu, Milind Sohoni
Several novel, point-of-care diagnostic devices are being rolled out in developing countries that can eliminate long diagnostic delays. Allocation of limited supply of these devices is based on thumb rules such as clinic size and disease burden. We develop an optimization model to study the impact of network externality on the allocation decision and analytically characterize conditions under which these rules of thumb are optimal. We apply our findings to infant HIV diagnosis network in an East African country.

3 - Subsidizing the Distribution Channel for Products with Positive Externalities
Prashant Yadav, MIT-Zaragoza International Logistics Program, Zaragoza Logistics Center, Zaragoza, MA, Spain, pyadav@mit.edu, Terry Taylor
Large populations in low income countries lack access to products, such as essential medicines, whose use confers positive externalities. A key question for a donor is whether it should subsidize the channel's purchases or sales of these products. We find the answer depends on whether consumers are homogeneous or heterogeneous in their valuation of the product. For the case of heterogeneous consumers' valuations, we show that subsidizing sales leads to greater expected donor utility, consumption, and social welfare. When consumers' valuations are homogeneous, we establish the opposite result.

TC04
04- Fontaine Ballroom F
Optimization in Rehabilitation and Orthopaedic Surgery
Cluster: Medical Decision Making
Invited Session
Chair: Kang Li, Assistant Professor, Rutgers University, Industrial & Systems Engineering, 96 Frelinghuysen Road, Piscataway, NJ, 08854, United States of America, kl419@rci.rutgers.edu
1 - Trade-off of Clinical Gait Evaluation - Causal Structures through Data Mining
Simon Hsiang, Derr Professor, Texas Tech University, Lubbock, TX, 79409, United States of America, simon.hsiang@ttu.edu, Tasos Karakostas, Luciano Dias
Clinical gait evaluation reflects a continuous effort for finding the trade-off among multi-objectives, including postural stability, mobility, energy conservation, and impact damping. The proposed data mining procedure is based on traditional regression analysis and machine learning methods. This framework consists of three optimization based algorithms and eliminates inter- and intra-operator variability associated with manual analysis. An application of this framework to 90 knee surface models yields several novel findings.

2 - Algorithms for Automated Femur Morphometric Analysis
Kang Li, Assistant Professor, Rutgers University, Industrial & Systems Engineering, 96 Frelinghuysen Road, Piscataway, NJ, 08854, United States of America, kl419@rci.rutgers.edu
This work proposes a new framework to enable automated analysis of the distal femur articular geometry. The framework consists of three optimization based algorithms and eliminates inter- and intra-operator variability associated with manual analysis. An application of this framework to 90 knee surface models yields several novel findings.

3 - Smart Home for Senior Citizens using Advanced Sensors
Zhihai Zhang, Associate Professor, Tsinghua University, Industrial Engineering, Beijing, 100084, China, zhzhang@tsinghua.edu.cn, Ying Su
The demand of home care for senior citizens in China is growing with ageing of the population. E-health is an emerging field in the intersection of medical informatics, public health and business, referring to health services and related technologies. The aim of our study is to investigate, specify, design, prototype, evaluate and analyze new, state-of-the-art eHealth system specifically tailored to senior citizens with multiple chronic diseases. Then, we can further improve the performance of the system, for example, resource allocation, by optimal technology.

TC05
05- Fontaine Ballroom G
Data Mining in Healthcare
Sponsor: INFORMS Computing Society
Sponsored Session
Chair: Erhun Kundakcioglu, Assistant Professor, University of Houston, E209 Engineering Bldg. 2, Houston, TX, 77204, United States of America, erhun@uh.edu
1 - Support Vector Machines for Toxicological Evaluation of Nanoparticles
Erhun Kundakcioglu, Assistant Professor, University of Houston, E209 Engineering Bldg. 2, Houston, TX, 77204, United States of America, erhun@uh.edu
In the present study, Raman spectroscopy is employed to assess potential toxicity of chemical substances. The database is constructed on healthy cells, Triton-X100, and etoposide exposed cells. Support Vector Machine classifiers and proposed extensions show that titania nanoparticles display cytotoxicity after 36 hours of exposure and heat effect results in apoptotic death. The results were confirmed by MTT assay and are in agreement with existing literature on the matter.
A new minimum spanning tree (MST) based heuristic is developed for clustering biological data. The heuristic uses MSTs to generate initial solutions and applies a local search to improve the solutions. MSTs are generated using common distance measures such as Euclidean and Manhattan. To obtain n clusters n-1 edges are removed from the MST. Betweenness values (i.e., number of shortest paths going along the edges) determine which edges to remove. Local search transfers a node to the cluster with which it has the most connections, if this transfer improves the objective function value.

3 - Pharmaceutical Inventory Management under Demand and Supply Uncertainty
Samra Saedi, PhD Student, University of Houston, Houston, TX, United States of America, ssaedi@uh.edu, Erhun Kundakcioglu, Andrea Henry

Drug shortages are a challenge for the healthcare community, since they appear without a warning and cost of managing patients increases when supplies for drugs are depleted. In this study, we propose an inventory management framework for pharmaceuticals, where the product's supply is randomly disrupted for a random duration. For operational purposes, current (s,S) policy of a hospital is kept, yet updated safety stock and order-up-to levels demonstrate a significant improvement over conventional tools.

2 - Resource-based START (ReSTART): Mass-Casualty Triage under Resource Limitations
Dimitrios Andritsos, UCLA Anderson School of Management, 110 Westwood Plaza, Los Angeles, CA, 90024, United States of America, dimitrios.andritsos.2011@anderson.ucla.edu, Chris Tang

Motivated by a recent legislative discussion in the European Union about providing European patients with the freedom to choose the country they receive treatment, we use a queuing framework to analyze a game-theoretic model that captures the interactions among the patients, the providers, and the healthcare funders. We examine the impact of such “free choice” on the healthcare systems of different countries in equilibrium. We show that cross-border patient movement can increase patient welfare but can have a mixed effect on waiting times and the costs of providing care.

2 - Appointment Scheduling under Patient No-shows and Service Interruptions
Jianzhao Luo, University of North Carolina, Chapel Hill, NC, 27599, United States of America, jzluo@email.unc.edu, Vidyadhar Kulkarni, Serhan Ziya

We consider an appointment-based service system (e.g., outpatient clinic, MRI machine etc.) for which appointments need to be scheduled before the service starts. Patients with scheduled appointments may or may not show-up for their appointments. The service of scheduled patients can be interrupted by emergency requests that have a higher priority. We develop a framework which can be utilized in determining the optimal appointment policies under different assumptions regarding rewards, costs, and the decision variables. We propose two methods that can be used in evaluating the objective function for a given appointment schedule. We specifically consider two different formulations both of which aim to balance the trade-off between the patient waiting times and server utilization and carry out a numerical study to provide insights into optimal policies. We find that policies that ignore interruptions perform quite badly, especially when the number of appointments to be scheduled is also a decision variable. We also find that policies that require equally-spaced appointments perform reasonably well when the interruption rate is constant. However, their performance worsens significantly when the interruption rate is time-dependent.

2 - Appointment Scheduling with No-Shows
Chair: Dionne Aleman, Assistant Professor, University of Toronto, Director, Medical Operations Research Laboratory (morLAB), Mechanical and Industrial Engineering, 5 King's College Road, Toronto, ON, M5S 3G8, Canada, aleman@mie.utoronto.ca

We consider an appointment-based service system (e.g., outpatient clinic, MRI machine etc.) for which appointments need to be scheduled before the service starts. Patients with scheduled appointments may or may not show-up for their appointments. The service of scheduled patients can be interrupted by emergency requests that have a higher priority. We develop a framework which can be utilized in determining the optimal appointment policies under different assumptions regarding rewards, costs, and the decision variables. We propose two methods that can be used in evaluating the objective function for a given appointment schedule. We specifically consider two different formulations both of which aim to balance the trade-off between the patient waiting times and server utilization and carry out a numerical study to provide insights into optimal policies. We find that policies that ignore interruptions perform quite badly, especially when the number of appointments to be scheduled is also a decision variable. We also find that policies that require equally-spaced appointments perform reasonably well when the interruption rate is constant. However, their performance worsens significantly when the interruption rate is time-dependent.

3 - Controlling Demand and Service Capacity for Appointment-based Services under Patient No-shows
Nan Liu, Columbia University, 600 W 168th St., 6th Floor, New York, NY, 10471, United States of America, nl2320@columbia.edu, Serhan Ziya

We model the appointment scheduling system as a single-server queue where new appointments join from the back of the queue. We assume that patients miss their appointments with probabilities increasing with their waiting time in queue. We consider 2 problems: (1) daily service capacity is fixed and the objective is to maximize throughput by choosing an appropriate panel size (or equivalently demand rate); (2) daily capacity is also a decision variable and the objective is to maximize the long-run average net reward (i.e., reward of serving patients less cost of maintaining service capacity).
inpatient beds for the community. We followed 150 patients on one year period so that we could understand the journey of an elderly patient from the emergency room to his hospital release. The method that we decided to use is based on lean.

2 - Improving Patient Flow and Performance within a Polyclinic
Onur Kuzgunyaka, Assistant Professor, Concordia University, Mechanical and Industrial Engineering, 1455 De Maisonneuve Blvd. West, EV 4.139, Montreal, QC, H3G 1M8, Canada, onurk@encs.concordia.ca, Robert Shek, Adnan Ali
Ambulatory polyclinics are multiple clinics that share assets and space, minimizing unused resources. Polyclinics are overcrowded and have long wait times. This study focuses on improving patient flow and providing alternative solutions to the polyclinic at Royal Victoria Hospital through simulation modeling and lean techniques. Key findings within this study include the best solution to organize multiple concurrent clinics, and the best practices to maximize quality of patient care and flow.

3 - Evaluating and Optimizing a Centralized Hospital Porter System
Jachwan Jeong, PhD Student, University of Tennessee, 916 Volunteer Blvd., 331 Stokely Management Center, Knoxville, TN, 37996, United States of America, jjeong3@utk.edu, Charles Noon
Within a hospital, porters play an important role by transporting patients between inpatient units, imaging services and treatment services. The responsiveness of a porter system directly affects the utilization of expensive assets (such as X-ray and MRI) and the efficiency of clinical staff (such as nurses and techs). Poor responsiveness results in idle time for waiting assets and causes clinical staff to be pulled away from direct patient care by having to assume the transportation responsibilities. Hospital transports are characterized by a mix of random and scheduled demands and by highly variable service times. In this work, we simulate the cost and responsiveness of an existing decentralized transport system and compare it to a proposed centralized (pooled server) system. We also determine the minimal staffing profile by hour of day needed to provide a target service level. The analysis is performed using data from a large U.S. hospital.

TC10
10- Westmount
Panel Discussion: Challenges and Opportunities in Transplant Operations Research
Cluster: Transplant Operations
Invited Session
Chair: Diwakar Gupta, University of Minnesota, 111 Church Street S.E., Minneapolis, MN, United States of America, gupta@me.umn.edu

1 - Challenges and Opportunities in Transplant Operations Research
Moderator: Diwakar Gupta, University of Minnesota, 111 Church Street S.E., Minneapolis, MN, United States of America, gupta@me.umn.edu, Panelists: Oğuzhan Alagoz, Dorry Segev, Ajay Israni, Stefanos Zenios, Vivek Farias
In the US, the demand for organs far outstrips supply. Organ Procurement and Transplant Network develops policies and procedures for organ recovery and distribution (allocation) to transplant candidates. This panel discussion will focus on challenges and opportunities in helping OPTN achieve one of its primary goals-to increase effectiveness and efficiency of organ sharing and equity in the national system of organ allocation.

TC11
11- Outremont
Health Care Supply Chains
Cluster: Invited Sessions
Invited Session
Chair: Gerardo Pelayo Rubio, PhD Student, Zaragoza Logistics Center, Edificio N-yade 5, C/ Barri 55, Zaragoza, Spain, g.pelayo@zlc.edu.es

1 - Screening for Colorectal Cancer: The Case of Resource Constraints
Evrim Didem Gunes, Assistant Professor, Koc University, Rumeli Feneri Yolu, Sariyer 34450, Istanbul, Turkey, EGunes@ku.edu.tr, Lerzan Ormeci, Derya Kunduzcu
We examine how the allocation of capacity constrained resources for preventive and diagnostic services might affect the health outcomes. Specifically, colonoscopy for screening and diagnosis of colorectal cancer (CRC) is considered. A population dynamics model with resource constraints is introduced. Mortality rates with different priority rules are compared numerically. We show that diagnostic services should obtain priority over screening for CRC case. An alternative approach is allocating a fraction of service capacity for screening.

2 - Donor Coordination/Harmonization: Impact of Restriction on the Health Outcome
Santiago Kraiselburs, Zaragoza Logistics Center, Zaragoza, Spain, skraiselburs@zlc.edu.es, Lijie Song, Ananth Iyer, Jorge Barnett
The OPTN has identified donor coordination as a key task. Improved coordination across donors may permit significant improvement in outcomes for the same level of resource commitment. We propose the use of a model based approach to assist the donor coordinated effort. The model was applied to the free health care program in Sierra Leone. It shows impact of 4 proposed configurations of the program to the total population health outcome under different demand scenarios.

3 - Modeling the Impact of Share Contracts on Pharmaceutical Companies, Healthpayers and Healthproviders
Gerardo Pelayo Rubio, PhD Student, Zaragoza Logistics Center, Edificio N-yade 5, C/ Barri 55, Zaragoza, Spain, g.pelayo@zlc.edu.es, Michael Borowitz, Santiago Kraiselburs, Prashant Yadav
The pharmaceutical industry faces intense pressures and new drugs for chronic conditions which typically enter the market at very high prices and have highest uncertainty regarding the health outcomes derived from an intervention are pushing towards reimbursement contracts where the risks are optimally shared. We model the relationship between a pharmaceutical company, a health-payer, and a health-provider to analyze different “reimbursement contracts-level of vertical integration” pairs and their effects on profits, coverage, and quality of the coverage.
Applications of Optimization in Healthcare

Sponsored Session
Chair: Chase Rainwater, Assistant Professor, University of Arkansas, 4207 Bell Engineering Center, Fayetteville, AR, 72701, United States of America, cer@uark.edu

1 - Evaluating the Capacity of a Proton Therapy Facility
Chase Rainwater, Assistant Professor, University of Arkansas, 4207 Bell Engineering Center, Fayetteville, AR, 72701, United States of America, cer@uark.edu, Ridvan Gedik, Edwin Romeijn

Due to the effectiveness and limited availability of proton therapy, the demand for this treatment is extremely high in relationship to the available capacity. Therefore, we propose a bicriteria mathematical programming model that maximizes the number of fractions and minimizes the deviations from the patient mix preferences over a finite planning horizon. Our study investigates the impact of various operational limitations faced by medical decision makers, such as: physician availability, operating hours, number of available ganttries, ganttry specialization and ganttry switching flexibility.

2 - Biologically Guided Intensity Modulated Radiation Therapy Optimization with Fraction Constraints
Behlul Saka, PhD Candidate, University of Arkansas, Fayetteville, AR, 72701, United States of America, bsaka@uark.edu, Ronald Rardin, Mark Langer

Although radiation therapy is typically planned as a single overall treatment, it is delivered over 30-50 sessions or “fractions,” and both cumulative and per-fraction dose constraints apply. The biological responses of tissues to radiation or “sensitivities” acquired from molecular images over this extended time calls adjusting radiation delivered across the treatment volume in order to yield more effective plans. We propose an optimization approach that adapts IMRT plans in response to the changes in the tumor sensitivity while meeting the dose requirements and present our results.

3 - Emergency Department Patient Flow Redesign
Soroush Saghalian, University of Michigan, Ann Arbor, MI, United States of America, soroush@umich.edu, Wallace Hopp, Mark Van Oyen, Steven Kronick, Jeffery Desmond

We consider a new patient flow design (called patient streaming) to overcome overcrowding in Emergency Departments. We investigate whether streaming can improve performance, where it is effective, and how it should be implemented for maximum performance. We also generate insights into how physicians should choose their next patient.

Learning and Sequential Decision-making in Medicine

Sponsored Session
Chair: Peter Frazier, Assistant Professor, Cornell University, 232 Rhodes Hall, Cornell University, Ithaca, NY, 14853, United States of America, pf98@cornell.edu, Andre Teixeira, Zachary Owen, Rodrigo Bicalho, Thiago Santos

We consider a stochastic root-finding problem appearing in the development of a new bacteriophage-based therapy for bovine mastitis. Experimentalists must find a critical concentration of a bacteriophage that slows a bacteria’s growth to a given level. We formulate the problem of finding this critical concentration as accurately as possible with a limited experimental budget as a Markov decision process, and solve the resulting dynamic program exactly. The resulting policy has a natural interpretation as a form of noisy bisection, and has potential application throughout medical research.

1 - Inverse Preference Elicitation for Sequential Decision Making
Dan Lizotte, Postdoctoral Fellow, University of Michigan, West Hall 431, 1085 S University Avenue, Ann Arbor, MI, 48109, United States of America, danlj@umich.edu, Susan Murphy

We present a novel approach for informing clinical sequential decision making that makes use of evidence-based predictions of treatment outcomes and makes room for clinician and patient preferences. We will present the intuition behind our approach, along with preliminary results in constructing a clinical decision support tool using our method.

2 - Towards Safer Retinal Microsurgery: Visualization Via Multispectral Illumination
Raphael Sznitman, Johns Hopkins University, 3400 North Charles St., Baltimore, MD, 21218, United States of America, sznitmant@gmail.com

One potential side effect of white light exposure during retinal microsurgery is retinal phototoxicity. To address this problem, one can illuminate the retina with a device that alternates between white, and less damaging limited-spectrum light. Using information from previous images, one can automatically color images from limited-spectrum light and provide the surgeon with fully colored video sequences. While trivial illumination policies can be used for retinal surgeries, the task of finding optimal policies given the safety of patient and the ability of a surgeon is non-trivial. As an initial solution towards this goal we have computed and implemented a greedy policy-one which chooses the best possible illumination to use for the following image. We experimentally show that our methods provides quantitative and qualitative improvements in coloring accuracy over other naive recoloring schemes and generally provides a reduction in estimated phototoxicity.

3 - Optimal Sequential Experimental Design for Stochastic Root-finding in Drug Development
Peter Frazier, Assistant Professor, Cornell University, 232 Rhodes Hall, Cornell University, Ithaca, NY, 14853, United States of America, pf98@cornell.edu, Andre Teixeira, Zachary Owen, Rodrigo Bicalho, Thiago Santos

We consider a stochastic root-finding problem appearing in the development of a new bacteriophage-based therapy for bovine mastitis. Experimentalists must find a critical concentration of a bacteriophage that slows a bacteria’s growth to a given level. We formulate the problem of finding this critical concentration as accurately as possible with a limited experimental budget as a Markov decision process, and solve the resulting dynamic program exactly. The resulting policy has a natural interpretation as a form of noisy bisection, and has potential application throughout medical research.

Tuesdays, 3:30pm - 5:00pm

Models for Healthcare System Improvement – Part II

Cluster: Invited Sessions
Invited Session
Chair: James Leaming, HLS Practice Director, InterKnowlogy, 1523 Faraday Blvd, Suite 250, Carlsbad, CA, 92008, United States of America, jleaming@interknowlogy.com, Marija Jankovic, Assistant Professor, Écoles Centrales Paris, Grande Voie des Vignes, Chatenay Malabry, 92290, France, marija.jankovic@ecp.fr, Julie Le Cardinal, Sara Ghiasi

Chronic diseases are diseases with long duration, slow progression and estimated more than 60% of overall causes of deaths in the world. Objective of this paper is to explore the possibilities of quality improvement, particularly for type 2 diabetes care. As a first step of this research, we propose a quality driven patient-centric process model for diabetes type 2 delivery services. Future work will consider data gathering and validation of the proposed quality indicators.

2 - Using Information Visualization to Think about Patient Management of Hypertension
Siddarth Prakasam, CIHDS Research Scholar, Pennsylvania State University, University Park, PA, United States of America, svp5228@psu.edu

According to the Center for Disease Control (CDC), 39% of US adults had hypertension in 2008. Given the chronic nature of the disease, it is critical that blood pressure levels are kept under constant surveillance. However, the health status reports given to patients are often misunderstood or ignored. With the focus of increasing understanding of health metrics through interactive visualizations of a patient’s status, a better tracking mechanism could improve patient adherence. We propose a glyph-based approach that provides a highly visual and quick comprehensible assessment of patient information. The glyph is in a shape that approximates the human body and uses color-coding to visually represent 17 key health metrics that pertain to the health status of a hypertensive patient. When created and viewed successively, the glyphs represent the progression in the patient’s health over a period of time. Such a tool may improve physician’s control over continuous patient monitoring and also help patients to better monitor their own health status between physician visits. From the physician’s perspective, the tool would enable decision-making efforts through its representation of large amounts of longitudinal clinical data. Further, this tool has the capability of enhancing collaboration between the patient, nurses, doctors and other caregivers. From a patient’s perspective, such an interface would help reinforce the physician recommendations and consequently the chronic condition could be kept under control. In future work, this tool may be developed for other chronic diseases.
HCBS from a cost-saving viewpoint. How much infrastructure is needed to provide HCBS. In this research, we than home and community-based service (HCBS). However, little is known on pressure. Although nursing home care is a viable option, it is much more costly paid LTC, the public programs paying for LTC are under increasing financial Long-term care (LTC) provides medical and non-medical services to people with the elderly with some requiring 24 hour long term care (LTC) while others better served in “supportive housing” (SH). This research determines the necessary capacity plan so that the number of clients waiting for LTC/SH in each hospital in the region remains close to a pre-determined threshold value and clients waiting in the community do not wait more than 90 days for placement.

1 - Long Term Care Capacity Planning
Martin Puterman, University of British Columbia, Sauder School of Business, Vancouver, BC, Canada, martin.puterman@sauder.ubc.ca

There has been plenty of discussion of the aging of our population and its impact on our ability to provide quality care. One must recognize a continuum of care for the elderly with some requiring 24 hour long term care (LTC) while others better served in “supportive housing” (SH). This research determines the necessary capacity plan so that the number of clients waiting for LTC/SH in each hospital in the region remains close to a pre-determined threshold value and clients waiting in the community do not wait more than 90 days for placement.

2 - Long Term Care Capacity Planning
Martin Puterman, University of British Columbia, Sauder School of Business, Vancouver, BC, Canada, martin.puterman@sauder.ubc.ca, Yue Zhang, Derek Atkins
This talk describes several approaches for setting residential care capacity levels over a multi-year planning horizon, to achieve target wait time service levels. This talk describes and compares a simulation optimization approach, a fixed ratio method, the SIPP approach and a simple flow model. It compares and contrasts these methods using data from two practical settings and shows the shortcomings of the SIPP and ratio methods.

3 - Capacity Planning for Publicly Funded Community Based Long-Term Care Services
Nan Kong, Assistant Professor, Purdue University, 206 S. Martin Jischke Dr., West Lafayette, IN, United States of America, nkong@purdue.edu, Laura Sands, Mark Lawley, Feng Lin
Long-term care (LTC) provides medical and non-medical services to people with chronic disease or disability. As a large portion of the population receives publicly paid LTC, the public programs paying for LTC are under increasing financial pressure. Although nursing home care is a viable option, it is much more costly than home and community-based service (HCBS). However, little is known on how much infrastructure is needed to provide HCBS. In this research, we formulate an optimal control problem to determine the infrastructure capacity of HCBS from a cost-saving viewpoint.
A Teaching Case on Decision Making

Case Studies: Unlocking the Value of Information
Contributed Session
Chair: John Newman, Professor, Coppin State University, 2500 W. North Avenue, Baltimore, MD, 21216, United States of America, jnewman@coppin.edu

1 - Developing a System for Body Shape Analysis that uses Body Shape Information and Biological Informat
Sekyoung Youn, Professor, Dongguk University, Pil-Dong 3ga, Jung-gu, Seoul, Korea, Republic of, sekyoungyoun@gmail.com, Sung-Ku Cho, Kyungwon Son
To this day, most people, to measure have relied on the BMI (Body mass index) that uses only the ratio of height and weight. However, a measurement system like the BMI is too simple a measure to evaluate a person's body type objectively and accurately. One obvious weakness of BMI would be its inability to distinguish between muscle weight and fat weight (BMI focuses on height and weight only). If people who work out hard mainly rely on the BMI, they will see no change in their BMI ratios even though their body weight composition is changing from fat to muscles. Therefore, a new system is needed for effective body measurement. This research developed a system that records the front and side of a body for effective analysis of body shape. This system is capable of measuring accurate body shape and suggesting an objective recommendation using database of body shape information. In addition, the research developed a system that can produce a diagnostic program to fix body-shape abnormalities that result from body imbalance. The existing systems lack the capabilities to analyze various bio-information and require manual operation for measuring various body parts. And also, they do not provide any useful measurement to predict imminent illnesses. For these reasons, developing a new system is needed to standardize and analyze automated images showing many dimensions of body parts, and to provide general health diagnosis using various bio-information. This research utilizes methodologies including product design methodology, risk analyses, quality controls, multivariate statistical analysis, and ubiquitous and mobile technology

2 - Adoption of OVA1: A Teaching Case on Decision Making
Vera Tilson, Assistant Professor, University of Rochester, Simon Graduate School of Business, CS 3-349 Carol Simon Hall, Rochester, NY, United States of America, vera.tilson@rochester.edu
Tying classroom material to current business events helps motivate and engage students. It also exposes them to examples of how to apply what they learn in practice. We present an example of how in a course on modeling with spreadsheets, we used a 2010 WSJ article about approval of a medical test for ovarian cancer to develop an exercise on conditional probabilities, sensitivity analyses, quality controls, multivariate statistical analysis, and ubiquitous and mobile technology

3 - A Conceptual Framework for a Clinical Decision Support System for Traumatic Brain Injuries
John Newman, Professor, Coppin State University, 2500 W. North Avenue, Baltimore, MD, 21216, United States of America, jnewman@coppin.edu
Recent research suggests that traumatic brain injury (TBI) is often misdiagnosed or not diagnosed at all. Treatment and follow-up care for TBI have been criticized. Recent prevalence of various degrees of TBI from military combat has given rise to high visibility issues. This paper presents a conceptual model for the diagnosis, treatment, and follow-up care of TBI. A computerized Military Clinical Decision Support Systems (MCDSS) can help identify the problems and opportunities within the current delivery of medical knowledge and expertise to help design an efficient and effective strategy to address TBI and other conditions for Military and civilian personnel

Medical Tourism: Can Developed Countries Compete on Quality with Developing Countries?
Hoseein Aboee Mehrizi, University of Toronto, Canada, Hoseezmehrizi@gmail.com
We consider a market with two hospitals competing for patients, one perceived to provide higher quality-of-care than the other. Patients select the hospital that provides the highest utility, which is a function of price, the patient's perceived quality-of-life during their life expectancy, and patient characteristics. We provide the existence and uniqueness of the Nash equilibrium by breaking the market down into seven different categories.

- Defining Constraint Models in the Real World: A Case Study on Chemotherapy Outpatient Scheduling
Shoshana Hahn, Ph.D. Candidate, University of Toronto, 294 Mullen Drive, Thornhill, ON, L4J 2P2, Canada, Shoshanahahn@yahoo.ca
The Operations Engineering team at Fraser Health is aiding the design of a new Breast Health Clinic that will be part of Fraser Health’s Onco-Surgical Centre scheduled to open in June 2011. Aligned to the Centre’s one-stop-shop care philosophy, clinic patients will be assessed as quickly as possible; seeing a specialist, undergoing tests and receiving most, if not all, of their results on the same day. A simulation model was built to derive integrated schedules between various departments, balancing patient needs & waits against resource utilization for efficiency and effectiveness.

Medical Back Matter
3 - Reducing Waiting Time in a Comprehensive Health Assessment
Opher Baron, Professor, University of Toronto, 105 St. George St.,
Toronto, ON, M5S 3E6, Canada, opher.baron@rotman.utoronto.ca,
Oded Berman, Jianfu Wang, Dmitry Krass

Modern healthcare is concerned with preventive, diagnostic, and treatment aspects of health problems. Often, the cost of treatment increases sharply if a problem is diagnosed late. We present a case study of a firm that is a leader in preventive healthcare in North America. Many of its customers are executives who highly value their time and prefer to check the候期 to minimal waiting times. A detailed simulation study of the firm allows us to find several surprising reasons for waiting and to recommend on process improvements that would improve the company’s service level.

3 - Workforce Scheduling for a Public Health Program
Nubia Velasco, Assistant Professor, Universidad de Los Andes,
Carrera 1 Este # 19 A, Bogotá, Colombia,
nvelasco@uniandes.edu.co, David Barrera, Ciro Alberto Amaya

This paper deals with the workforce scheduling problem for a public health program in Bogotá. In this, a group of schools demands one or more activities and defines, for each one, a set of desirable schedules to be served. To fulfill this demand, a set of workers is available and must be decided which worker will visit which school and when. Our approach uses a directed graph and to solve it we perform some specific numerical analysis.

2 - The Impact of Order Loss and Shrinkage on a Single-item Pharmaceutical Inventory
Ozden Engin Cakici, University of Rochester, William E Simon Graduate School, Rochester, NY, United States of America,
cengin.cakici@simon.rochester.edu, Harry Groenevelt, Abraham Seidmann

The management of pharmaceuticals in a hospital setting requires special considerations, and has significant impact on the cost of care. In this paper, we analyze two major drivers of suboptimal inventory management in a hospital setting: (1) order losses and (2) formularies shrinkage. Order loss is a supply disruption caused by the buyer itself. Our empirical observations at a large hospital show that replenishment orders for pharmaceuticals issued by the radiology department must go through multiple other units for verification, authentication, safety checking, and consolidation, before they are ultimately submitted to a supplier for fulfillment. As a result, a certain portion of the restocking orders is inadvertently lost on the way. Shrinkage, on the other hand, is typically caused by the mandatory disposal of partially used drug packages. Various drugs (e.g., contrast media for medical imaging) are bought by the hospitals in larger packages as a way to cut cost, and they are used intravenously for more than one patient. The typical FDA regulations on these drugs require that, once a vial is opened, any unused portion must be discarded after a short period of time (e.g., 10-24 hours).

2 - Modelling the Dynamics of a Risk Sharing Agreement
Reza Mahjoub, University of Western Ontario, Richard Ivey School of Business, London, ON, N6A 3K7, Canada,
rmahjoub@ivey.uwo.ca, Fredrik Odegaard, Greg Zaric

Some new drugs such as oncology drugs are very costly and their effectiveness outside of clinical trial conditions may be unproven. A risk sharing agreement is a contract between the drug manufacturer and a healthcare payer to manage uncertainties regarding the cost and effectiveness of those drugs. We model a risk sharing scheme where the rebate is a percentage of the total sales until an evaluation time. We examine the dynamics of this risk sharing agreement from a pharmaceutical perspective. We fit the model to the data from a clinical trial and perform some specific numerical analysis.

1 - A Nurse Staffing Analysis at a Large Hospital
Mohamed Louly, King Saud University, P. O. Box 800, Riyadh,
11421, Saudi Arabia, louly@ksu.edu.sa, Abdelghani Bouras,
Anis Gharbi, Mohamed Naceur Azaiez

The hospital faces a shortage of 300 Full Time Equivalent (FTE) nurses. The management adopted the policy of substituting these 300 FTE vacancies by allowing additional load to the existing nurses. These extra loads result in an overtime cost at the rate of 1.1 times the regular rate. The overtime allocated budget is 11.5 million U.S.D. The top management of the hospital considers this budget to be excessive. Another potential negative impact of this substitution strategy may be the risk of yielding poor nursing services due to substantial overload caused by the excessive overtime on most of the nurses.

1 - Nurse Rostering in a Danish Hospital
Jonas Baeklund, Aarhus University, Department of Mathematical Sciences, Denmark, jonas@baeklund.info

Nurse rostering is a well-studied, but complex scheduling problem. The problem we confront is a nurse rostering problem in a ward at a Danish hospital. After a description of the problem, the results obtained by adapting a branch and price / constraint programming solution method to the problem are presented.

TD09
09- Cote St. Luc
Modeling in Pharmaceutical Market
Cluster: Pharmacoeconomics
Invited Session
Chair: Hui Zhang, Lakehead University, 955 Oliver Road, Thunder Bay, Canada, hzhang2@lakeheadu.ca

1 - Dynamic Capacity Expansion for a New Ethical Drug with Partial Outsourcing Options
Hiroya Okajima, PhD Student, The Pennsylvania State University,
467 Business Building, University Park, PA, 16802,
United States of America, hu104@psu.edu, Susan H. Xu

We investigate a pharmaceutical manufacturer's jointly optimal in-house capacity and short-term outsourcing policy during the life-span of a new drug to minimize the expected capacity investment costs and capacity overage and undercosts. We formulate the problem as a discrete-time, finite-period stochastic dynamic program and use real options approach. The optimal policy is determined by two state-dependent base-capacity levels. A numerical study shows that short-term outsourcing has both strategic and tactical advantages to mitigate capacity imbalance in uncertain business environment.

1 - Analysis of Kidney Transplant Center Locations in the United States
Mark Daskin, PhD, University of Michigan, 1205 Beal Ave, Ann Arbor, MI, 48109, United States of America,
mdaskin@umich.edu, Daniela Ladner, John Friedewald, Sanjay Mehrotra, Vadim Lyuksemburg, Ashley Davis, Aaron Skaro, Michael Abecassis, Juan Carlos Caicedo

The distance stage end renal disease (ESRD) patients travel to kidney transplant centers (KTCs) is predictive of their listing and receiving a kidney transplant. We analyze the geographic distance traveled by ESRD patients to their closest existing US KTC, and compare the resulting coverage to an optimized model aimed at maximizing geographic access by minimizing the total travel distance faced by ESRD patients to their closest KTC. Findings show that presently, 64% of ESRD patients live within 30 miles of a KTC. Through optimal relocation, 79% of ESRD patients live within 30 miles of a KTC.

2 - The Value of Partially Observable Liver Transplant Waiting List
Burhaneddin Sandikci, Assistant Professor, University of Chicago Booth School of Business, 5807 South Woodlawn Avenue, Chicago, IL, 60637, United States of America,
Burhaneddin.Sandikci@chicagobooth.edu, Lisa Maillart, Mark Roberts, Andrew Schaefer

In the United States, patients in need of a liver transplant receive deceased-donor organ offers through joining a waiting list. Accepting or rejecting an offered organ is largely influenced by the patient’s prospects for future offers, which can be ascertained most accurately by knowing the entire composition of the waiting list. We present a model that uses the partially observable waiting list as available in the current system to make optimal accept/reject decisions along with our numerical results investigating the impact of this imperfect information on patients’ life expectancies.
3 - The Natural History of MELD
Gordon Hazen, Northwestern University, IEMS Department, McCormick School, Evanston, IL, United States of America, gh30@lululemon.northwestern.edu, Zhe Li
The U.S. liver transplant wait list is prioritized by MELD, a combination of laboratory values positively correlated with 90-day mortality. SRTR publishes 30-day MELD transition data appropriate for Markov modeling. However, the data shows some MELDs may likely improve, as evidenced by listed candidates shifting on average expect worsening MELDs. We hypothesize this is due to censoring by transplant, and fit a statistical model that allows this using the EM algorithm. The fitted model confirms transplant censoring and produces estimates of the natural history of MELD without transplant.

■ TD11
11- Outremont
Operational Models of Drug Resistance
Cluster: Invited Sessions
Invited Session
Chair: Eirini Spiliotopoulou, PhD Student at MIT-Zaragoza, Zaragoza Logistics Center, Edificio Náyade 5, C/ Bari 55 - PLAZA, Zaragoza, 50197, Spain, espiliotopoulou@zlc.edc.es
1 - Designing Dynamic Adaptive Clinical Trials
Vishal Ahuja, Graduate Student, University of Chicago, Booth School of Business, 5807 Woodlawn Ave., Chicago, IL, 60637, United States of America, vahuja@chicagobooth.edu, John Birge
We develop dynamic algorithms for clinical trial design. Such algorithms allow for altering treatment during the course of a trial by utilizing information learned from the past and considering future possibilities. We demonstrate that dynamic designs yield better outcomes compared to traditional randomized clinical trials.

2 - Using Multiple First-line Therapies (MFT) to Treat Malaria
Maciej F. Boni, Hospital for Tropical Diseases, Wellcome Trust Major Overseas Programme, Oxford University Clinical Research Unit, Vietnam, mboni@occr.u.org
Despite the availability of many drugs and therapies to treat malaria, many countries’ national policies recommend using a single first-line therapy for most clinical malaria cases. To assess whether this is the best strategy for the population as a whole, one can design a mathematical model focusing on the evolutionary epidemiology of malaria. In this modeling framework the benefits of different treatment strategies can be evaluated in the context of resistance evolution. Using several such frameworks, our results show that the population-wide use of multiple first-line therapies (MFT) against malaria yields a better clinical outcome than using a single therapy or a cycling strategy where therapies are rotated, either on a fixed cycling schedule or when resistance levels or treatment failure become too high. MFT strategies also delay the emergence and slow the fixation of resistant strains (phenotypes), and they allow a larger proportion of the population to be treated without trading off future treatment of cases that may be un-treatable because of high resistance levels. MFT strategies are also affected by drug type (e.g. artemisinin) and drug half-life, but by and large, they are more effective than current strategies. Effects of drug stocks outs and variation in drug availability will be shown and discussed.

3 - Supply Chain and Resistance Implications of Drug Variety
Eirini Spiliotopoulou, PhD Student at MIT-Zaragoza, Zaragoza Logistics Center, Edificio Náyade 5, C/ Bari 55 - PLAZA, Zaragoza, 50197, Spain, espiliotopoulou@zlc.edc.es, Prashant Yadav
Extending a simple general disease model to include the emergence and evolution of resistance, we quantify the benefits associated with drug variety, and compare them against the cost of higher variety in the supply chain (procurement and safety stock holding costs). We apply the model for the case of malaria treatment. Our model lends insights to policy makers into the socially optimal size of the drug assortment.

■ TD12
12- Verdun
OR Applications in Healthcare
Sponsor: INFORMS Optimization Society
Sponsored Session
Chair: Fatih Safa Erenay, Assistant Professor, University of Waterloo, 200 University Avenue West, Waterloo, ON, 53706, Canada, ferenay@connect.uwaterloo.ca
1 - Optimizing Colorectal Cancer Screening Policies Considering Screening and Treatment Costs
Fatih Safa Erenay, Assistant Professor, University of Waterloo, 200 University Avenue West, Waterloo, ON, 53706, Canada, ferenay@connect.uwaterloo.ca, Oguzhan Alagoz, Adnan Sald