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Service Spotlights

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Decision Support for the Physician Scheduling Process at a German Hospital (p. 215)

In many hospitals, senior physicians are charged with the virtually impossible task to manually construct lawful monthly working schedules for their departments while taking into account individual assignment requests and balancing worktime and budget concerns. The vast array of existing rules and regulations, the heterogeneity of the workforce, and the varying number of days, weeks, and work holidays within the individual months make this a very time-consuming and error-prone task. The authors develop an optimization model that formalizes every rule and regulation necessary to generate lawful schedules in the anesthesiology department of a 626-bed hospital in Berlin, Germany. The new approach highlights important aspects in modeling the physician scheduling problem for practical implementation that have been widely ignored in the existing literature. Test over a six month period, the study shows that schedules generated by the model outperform the ones that were manually created and assigned in practice by significantly reducing the number of rule and regulation violations and improving key performance measures, such as assigned overtime, granted employee-preferred shifts, and fairness considerations.

Women's College Hospital Uses Operations Research to Create an Ambulatory Clinic Schedule (p. 230)

Women's College Hospital (WCH) in Toronto, Canada offers roughly 300 outpatient clinics every week. In this article, the authors describe a project started in April 2011 with WCH to design a new schedule for their clinics to accommodate a move to a new hospital building, which was completed in May 2013. They developed an integer programming model to optimize the assignment of clinics to timeslots and locations, based on the desire to minimize changes from the historical schedule. In cooperation with senior leadership of WCH, the authors tested multiple scenarios that explored changes to space utilization policies at WCH and ultimately generated a new clinic schedule, which WCH implemented in May 2013. In this paper the authors highlight the value the work has created for WCH and present lessons learned in development of the model and through collaboration with the WCH team.

Stochastic Appointment Scheduling in a Team Primary Care Practice with Two Flexible Nurses and Two Dedicated Providers (p. 241)

Waiting is common in appointment-based outpatient care: patients experience delays before seeing a nurse and then in the examination room before seeing the doctor. Given that service times are uncertain, the challenge for outpatient practices is to control the spacing between successive appointments to minimize waiting time while ensuring the doctor is not idle for too long. Whereas scheduling in single-doctor practices is well studied, *team practice*, in which one of two nurses can flexibly see the patient before the patient consults with one of two assigned doctors, is not. Optimal scheduling in a team practice is far more challenging from a computational viewpoint because the order in which patient appointments are scheduled need not be the order in which they see their doctors (i.e., patients may be allowed to crossover). In this article the authors propose a model that can solve realistic instances of this problem optimally. On the basis of analyses, the results show that (1) empty slots (which function as slack to alleviate waiting) alternate in the two doctors' schedules and do not occur simultaneously, and (2) allowing nurse flexibility and patient crossovers produces greater benefits when service time variation is high.

Optimization of Telemedicine Appointments in Rural Areas (p. 261)

What is the optimal number of patients to schedule for a telemedicine clinic, and when should they be scheduled to arrive? Telemedicine services are increasingly being used to provide medical care to patients in rural areas; thus, it is important to determine the best way to schedule patients given factors such as length of the clinic day, time needed to sanitize procedure equipment, and patients missing their appointments. The authors provide scheduling insights for a telemedicine clinic that provides procedures for bladder cancer surveillance in rural Virginia. They find that between five and seven patients should be scheduled for this clinic depending on whether the clinic would rather minimize provider overtime (five patients) or see as many patients as possible without excessive overtime

(seven patients). When minimizing provider overtime, it is recommended to schedule patients close together at the beginning of the day and after lunch, because some patients may not come to their appointments. The findings from this work have informed scheduling practices at the telemedicine clinic in rural Virginia. The insight for management is that optimal appointment scheduling has the potential to reduce provider downtime between patients and efficiently allow more patients to benefit from specialty care via telemedicine.

A Stochastic Programming Approach for Appointment Scheduling Under Limited Availability of Surgery Turnover Teams (p. 277)

The number and availability of turnover teams may significantly affect the performance of a surgery schedule. In this paper, the author refines a surgery schedule by considering the limited availability of turnover teams and uncertainty in the durations of surgical operation and turnover. The objective is to minimize the competing criteria of expected patient waiting time and operating room idle time. The author evaluates the impact of the number of turnover teams into the surgery schedules with respect to performance criteria of interest. The insight for management: The performance of the schedules highly depends on the number of turnover teams. The schedules perform poorly in the case where the ratio of the number of turnover teams to the number of operating rooms (ORs) is $1/4$. The ratio of $1/2$ may help OR managers obtain reasonable performance measure values.

A Data-Driven Procedure of Providing a Health Promotion Program for Hypertension Prevention (p. 289)

How can service providers efficiently and effectively implement a health promotion program to prevent hypertension? In this article, the authors propose a two-step procedure based on data analytics using (1) a prediction model to identify people who are at risk for developing hypertension and (2) four methods to create an index that represents the importance of specific intervention programs for eliminating risk factors for individuals. The authors use the national sample cohort database of South Korea to offer a case study of the implementation of the proposed procedure. The constructed prediction model using logistic regression has adequate accuracy, and the proposed index has results similar to those of a doctor. The insight for hypertension prevention program implementation: This two-step procedure, which relies on automatic modeling based on data, can provide informative and personalized results based on individual health records.

A Stochastic Game Analysis of Incentives and Behavioral Barriers in Chronic Disease Management (p. 302)

Chronic diseases, such as hypertension, diabetes or coronary heart disease, account for more than \$1 trillion of healthcare costs and lost productivity in the United States. The occurrence and costly effects of chronic diseases can often be prevented or delayed, and their negative impact can be mitigated by changing the behavior of patients and physicians. Incentives are one of the mechanisms to motivate such change. In this paper, the authors use a stochastic game model to investigate the incentives and behavioral barriers that influence the decisions of patients regarding primary care engagement and lifestyle, as well as physicians' effort spent during clinical encounters. The results quantify how incentives and behavioral barriers affect patients' engagement in health promoting activities and physicians' delivery of primary care services. Generally, the findings show that lowering copays and reducing psychological barriers encourages health beneficially actions by patients, while a shift towards value-based and outcome-based reimbursements increases the effort by physicians, which positively impacts patients. The paper provides insights for payers and policy makers on how incentives and payment innovations affect patients, physicians, payers and society at large. The mathematical model can be used to support the design of effective incentive mechanisms in chronic disease management.

Optimal Liver Acceptance for Risk-Sensitive Patients (p. 320)

To be eligible for a cadaveric liver transplant in the United States, a patient must join a waiting list maintained by UNOS, which allocates livers using a complex priority system. When a liver offer is made, each patient must decide whether to accept the offer. Although a vast majority of patients are known to be risk-sensitive when making health-related decisions, earlier work on organ-acceptance decisions assumes that patients are risk-neutral and maximize life expectancy. We extend previous research by including patient risk preferences in modeling patient decision making. They illustrate that for a given health state (or liver quality), the best decision is to accept an offer if liver quality (or health state) is higher (or worse) than a certain threshold level and that these threshold levels depend on the risk preferences of the patient. Numerical studies reveal that assuming risk neutrality may lead to substantial losses in expected utility, particularly when a sicker patient receives a lower-quality liver offer. The insight for decision makers: Because of patient risk preferences, a life expectancy-maximizing liver-acceptance policy is not necessarily the best policy; it may actually cause significant losses in expected utility.

Exploring the Value of Waiting During Labor (p. 334)

Of the nearly 4 million births that occur each year in the United States, almost one in every three is a cesarean delivery or C-section. Despite the increasing C-section rate over the years, there is no evidence that the increase has caused a decrease in neonatal or maternal mortality or morbidity. In this article, the authors use Bayesian decision analysis to model the decision between classifying a patient as “failure-to-progress,” which is cause for a C-section, using either current information (prior probability) or information gathered (posterior probability) as labor continues. The Bayesian decision models determine the conditions under which it is appropriate to gather additional information (i.e., take an observation) prior to deciding to end labor and perform a C-section based on the decision maker's belief of successful labor. During an observation period, the decision maker learns more about the patient and her medical state and the likelihood of a successful vaginal delivery is updated. This study determines the conditional value of information (conditional on the decision maker's prior belief) and determines the conditions under which information has positive value. This model can be used to facilitate shared decision making for labor and delivery through communicating beliefs, risk perceptions, and the associated actions.

Trial Termination and Drug Misclassification in Sequential Adaptive Clinical Trials (p. 354)

Sequential adaptive clinical trials allow for early termination of drug testing at interim analysis points if the evidence suggests that the candidate drug or therapy is effective (stopping for benefit) or that the drug will not demonstrate to be better than existing therapies (stopping for futility). Early stopping allows the trial sponsor to mitigate investment risks on ineffective drugs and to shorten the development timeline of effective drugs, thus reducing costs and expediting patients' access to these new therapies. However, this new flexibility may translate into a higher risk of deriving incorrect conclusions from the trial in the form of false positives or false negatives. The authors examine the causes and implications of wrongly terminating the development of an effective drug, which may lead to unrecoverable expenses and unfulfilled patient needs. The authors find that the risk of deriving incorrect conclusions from the trial increases with the number of interim analyses performed throughout its course. The insight for management: Contrary to the literature's focus on false positives, false negatives can be more likely; thus, whenever the drug's characteristics and the targeted disease permit, aggressive trial designs should be chosen over conservative ones to detect small but beneficial treatment differences.