OR FOR PATIENT-CENTERED HEALTH CARE DELIVERY

36th International Conference of the
EURO Working Group on
"Operational Research Applied to Health Services"

GENOVA (ITALY)
18-23 JULY 2010

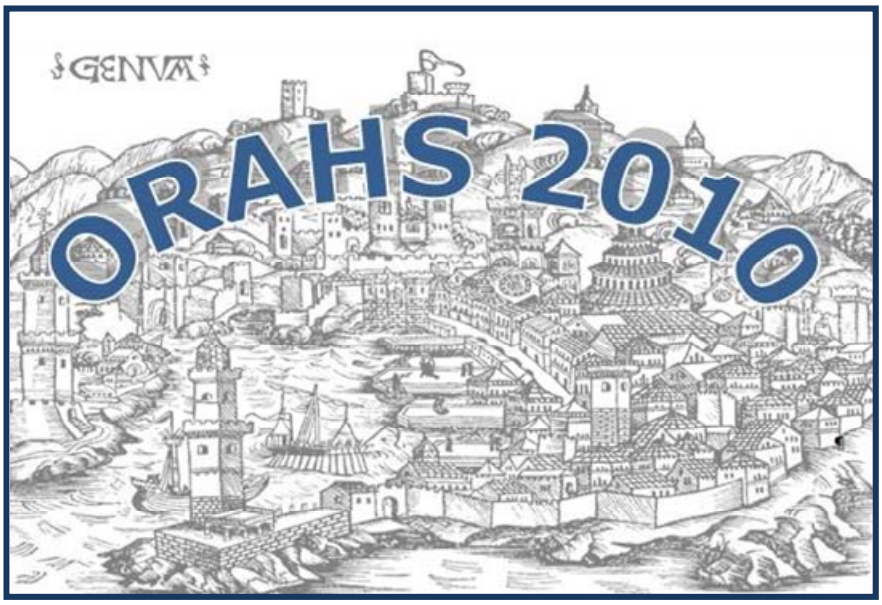
ABSTRACT BOOK

ISBN 9788890472053

OR FOR PATIENT-CENTERED HEALTH CARE DELIVERY

36th International Conference of the
EURO Working Group on
"Operational Research Applied to Health Services"

GENOVA (ITALY)
18-23 JULY 2010



ABSTRACT
BOOK

Published by Centro Stampa. Università degli Studi di Genova.

AA.VV.
Eds by Angela Testi, Elena Tànfani, Enrico Ivaldi, Giuliana Carello, Roberto Aringhieri, Vito Fragnelli

ISBN - 9788890472053

Printed in Italy

Index

Scientific Committee

Roberto Aringhieri (IT)
Duncan Boldy (AU)
Sally Brailsford (UK)
Michael Carter (CA)
Vanda De Angelis (IT)
Erik Demeulemeester (BE)
Mario Jorge Ferreira de Olivera (BR)
Erwin Hans (NL)
Paul Harper (UK)
Yasar Ozcan (USA)
Marion Rauner (AT)
Elena Tanfani (IT)
Angela Testi (IT)
Jan Vissers (NL)
Xiaolan Xie (FR)

Organizing Committee

Angela Testi - *University of Genova (Conference Chair)*
Roberto Aringhieri - *University of Torino*
Giuliana Carello - *Politecnico of Milano*
Vito Fragnelli - *University of Piemonte Orientale*
Enrico Ivaldi - *University of Genova*
Elena Tànfani - *University of Genova*

SCIENTIFIC SCHEDULE

SCIENTIFIC SCHEDULE

	Monday, July 19th	
8.30 - 9.00	***Registration***	
9.00 - 10.00	ORAHS Welcome	
10.00 - 11.00	**Plenary session** **Gino Gumirato:** Inside the US Health Care Reform	
11.00 - 11.30	***Coffee Break***	
11.30 - 13.00	**M1_A**	**M1_B**
	Patient flow (1) *Chair: Yasar Ozcan* 1. **Daniel Gartner, Rainer Kolisch:** DRG-based resource allocation and patient flow management in hospital 2. **Maria de Lourdes Guzman Castillo**, **Sally Brailsford, Honora Smith:** Modelling patient length of stay in Mexican public hospitals 3. **Yasar Ozcan:** Clinical Pathways: A dual approach to implement and assess Clinical Pathways 4. **Dave Worthington, Philip Worrall:** Long Term Planning for COPD in Derbyshire County PCT	Epidemiology & Disease modelling (1) *Chair: Israel Vieira* 1. **Nikolaos Rachaniotis, Tom Dasaklis, Costas Pappis:** A deterministic scheduling model in epidemic's control with multiple resources 2. **Alexander Rutherford, Pouya Bastani, Bojan Ramadanovic, Krisztina Vasarhelyi, Rolando Barrios:** Reducing HIV-related Acute Care Admissions through Drug Treatment Program Expansion 3. **Christian Viladent**, **Ann van Ackere:** A deterministic model to assess the impact of circumcision and other interventions in countries with generalized HIV epidemic. An application to Botswana 4. **Israel Vieira**, **Valter de Senna:** Simulation model for the evaluation of HIV vaccine intervention
13.00 - 14.15	***Lunch***	
14.15 - 15.45	**M2_A**	**M2_B**
	Appointment scheduling *Chair: Domenico Conforti* 1. **Mehmet Begen**, **Retsef Levi, Maurice Queyranne:** Exact and Sampling-Based Methods for Appointment Scheduling with Discrete Random Durations 2. **Arda Ceylan, Murat Günal:** A Generic Outpatient Appointment System Simulation Model 3. **Domenico Conforti, Francesca Guerriero, Rosita Guido:** Week Hospital Inpatient Flow Management 4. **Zhecheng Zhu, Bee Hoon Heng, Kiok Liang Teow:** Application of Genetic Algorithm on Outpatient Clinic Appointment Scheduling	Epidemiology & Disease modelling (2) *Chair: Vanda De Angelis* 1. **Sally Brailsford, Christine Currie, Paul Davie:** Modelling for seasonal influenza: combining agent-based simulation and social network models 2. **Paula González-Parra, Leticia Velázquez, Maria Villalobos, Gerardo Chowell, Carlos Castillo-Chávez:** Optimal Control Applied to a Discrete Influenza Model 3. **Mariagrazia Mecoli, Vanda De Angelis, Sally Brailsford:** Modelling intervention strategies for mosquito-borne diseases: The case of human travel between geographical regions **4. Christina Pagel, Sonya Crowe, Guy Walker, James Haybyrne, Peter Grove, Martin Utley:** Can we mitigate the effects of an influenza pandemic by vaccinating against pneumonia?
15.45 - 16.15	***Coffee Break***	
16.15 - 17.15	**M3_A**	**M3_B**
	OR planning and scheduling (1) *Chair: Elena Tànfani* 1. **Isabelle Beaulieu, Michel Gendreau, Patrick Soriano:** Operating Rooms Scheduling under Uncertainty 2. **Domenico Conforti, Maria Elena Bruni**, **Patrizia Beraldi:** Scheduling operating rooms under uncertainty: a stochastic programming	Logistics (1) *Chair: Mario Jorge Ferreira de Oliveira* 1. **Giuliana Bensa, Stefano Villa, Isabella Giusepi:** Costs and benefits of innovation in healthcare logistics: evidences from two case studies 2. **Mário Jorge Ferreira de Oliveira, Rodrigo Abrunhosa Collazo, Leonardo Antonio**

	approach 3. **Elena Tànfani, Angela Testi, Rene Alvarez:** A two-level resolution approach for the stochastic OR planning problem	**Monteiro Pessôa, Leonardo Claro Garcia:** Simulation of multiple views of medicine distribution in a navy hospital pharmacy 3. **Laura Gaetano, Gabriella Balestra:** An innovative procedure for the localization of health care devices and services
17.15 – 19.30	***Guided tour of Genova***	
19.30 – 21.30	***Reception at Town Hall (Palazzo Tursi)***	

SCIENTIFIC SCHEDULE

	Tuesday, July 20th	
	T1_A	**T1_B**
9.00 - 10.30	OR planning and scheduling (2) *Chair: Michael Carter* 1. **Roberto Aringhieri, Paolo Landa, Patrick Soriano, Elena Tànfani, Angela Testi:** A Tabu Search approach for joint operating room assignment and scheduling 2. **Michele Ciavotta, Gabriella Dellino, Carlo Meloni**, **Marco Pranzo:** A Rollout Algorithmic Approach for Complex Parallel Machine Scheduling in Healthcare Operations 3. **Domenico Conforti, Francesca Guerriero, Rosita Guido:** Operating Room Planning and Scheduling: a Multiobjective Model solved via Genetic Algorithm 4. **Mohammad-Taghi Fatemi-Ghomi**, **Saeedeh Ketabi, Mehdi Mahnam:** Surgical Services Efficiency and Hospital Capacity	Planning health services (1) *Chair: Erik Demeulemeester* 1. **Nancy Khurma, Zbigniew Pasek:** Analysis, Modeling and Improvement of Patient Discharge Process in a Regional Hospital 2. **Guoxuan Ma, Erik Demeulemeester:** Assessing the performance of capacity planning through simulation analysis 3. **Jonathan Patrick:** Capacity Planning and Scheduling for Long Term Care 4. **Peter Vanberkel:** Hospital Expansion Planning-Achieving Treatment Growth Targets
10.30 - 11.00	***Coffee Break***	
	T2_A	**T2_B**
11.00 - 12.30	EMS (1) *Chair: Giuliana Carello* 1. **Bernardetta Addis, Roberto Aringhieri, Giuliana Carello**, **Andrea Grosso, Francesco Maffioli:** Models for the optimal composition of medical crews in emergency services. 2. **Edoardo Amaldi, Stefano Coniglio, Claudio Iuliano:** Single and multi-group evacuation in medium and maxi health-care emergencies 3. **Tomi Malmström, Paulus Torkki, Raija Malmström:** Triage and routing of emergency patient – optimal level for triage 4. **Monia Rekik, Jacques Renaud, Angel Ruiz:** Design of Logistics Networks for Disaster Relief	Planning health services (2) *Chair: Paul Harper* 1. **Tom Bowen:** Idealised Design and Modelling of Alternatives to Hospital Care 2. **Paul Harper:** Discrete conditional phase-type models utilising classification trees: application to modelling maternity services 3. **Penelope Mullen:** Establishing weighting criteria for prioritising health care services for professionals, patients and the public 4. **Honora Smith:** Predicting future capacity needs for healthcare services at strategic and tactical levels
12.30 - 13.45	***Lunch***	
13.45 - 17.30	Inside the Italian Health Care System: Gaslini Children Hospital Tour	
17.30 - 19.30	**Symposium (TH3)**	
	"Modelling the care of younger people" *Chair: Angela Testi* 1. **Giada Aspergh, Paola Facchin, AnnaFerrante, Giorgio Romanin-Jacur, Laura Visonà-Dalla-Pozza:** Pediatric palliative care organization simulation model 2. **Michela Chessa**, **Stefano Gagliardo:** Where Is the Profit in Rare Diseases Research? 3. **Sonya Crowe, Christina Pagel, Kate Bull, Matthew Fenton, Christos Vasilakis, Steve Gallivan, Martin Utley:** Applying OR to the problem of paediatric heart transplant waiting lists and 'bridging' technologies 4. **Paola Facchin, Anna Ferrante, Elena Rizzato, Giorgio Romanin-Jacur, Laura Salmaso:** Perinatal Assistance Network Planning Via Simulation 5. **Paul Forte:** Workforce modelling in paediatric gastroenterology	

SCIENTIFIC SCHEDULE

<table>
<tr><th></th><th colspan="2">Wednesday, July 21st</th></tr>
<tr><td rowspan="2">9.00 - 11.00</td><td colspan="2">Symposium (W1)</td></tr>
<tr><td colspan="2">“Modelling the care of older people”
Chair: Duncan Boldy
1. Paul Forte, Tom Bowen: The Balance of Care approach: modelling complexity in services for older people
2. Mårten Lagergren: Longitudinal area-databases for monitoring and analysis of the care-of-the-elderly system in Sweden
3. Duncan Boldy: Modelling the determinants of resident satisfaction in aged care facilities
4. Giulia Garavaglia, Emanuele Lettieri, Tommaso Agasisti, Cristina Masella, Salvatore Silvano Lopez: Patient-centered care and efficiency in nursing homes
5. Angela Testi, Enrico Ivaldi, Elena Tànfani: Assessing nursing home costs: a patient-centered perspective</td></tr>
<tr><td>11.00 – 11.30</td><td colspan="2">Coffee Break</td></tr>
<tr><td rowspan="2">11.30 - 13.00</td><td>W2_A</td><td>W2_B</td></tr>
<tr><td>OR planning and scheduling (3)
Chair: Jan Vissers
1. Rene Alvarez, Richard Bowry, Michael Carter: Prediction of the Time to Complete a Series of Surgical Cases to Avoid Operating Room Overutilization
2. Fabio Fruggiero, Alfredo Lambiase, Alessandro Braione: Towards an optimal mix in planning and scheduling of operating theatres
3. Jan Vissers, Ivo Adan, Jos Bekkers, Nico Dellaert, Jully Jeunet: Improving operational effectiveness of tactical master plans illustrated with cardiothoracic surgery
4. Cheryl Voake, Jeff Griffiths, Janet Williams: Modelling trauma hip fracture patients: the impact on operating theatres and the orthopaedic ward</td><td>Epidemiology & Disease modelling (3)
Chair: Sally Brailsford
1. Marek Lubicz, Piotr Piszko, Bożena Mielczarek, Jacek Zabawa: Quantitative Decision Support for CardioVascular Medicine: WROVASC project
2. Nishikant Mishra, Sanja Petrovic, Santhanam Sundar: Self-adaptive case based reasoning for dose planning in radiotherapy
3. Syed Mohiuddin, Sally Brailsford: Enabling health, independence and wellbeing for bipolar patients via Personalised Ambient Monitoring (PAM)
4. Martin Utley, Francesca Fiorentino, Tom Treasure: Obtaining an upper estimate of the survival benefit associated with major surgery for mesothelioma</td></tr>
<tr><td>13.00 – 19.30</td><td colspan="2">Boat trip to San Fruttuoso e Portofino</td></tr>
<tr><td>19.30 – Late</td><td colspan="2">Farinata, Focaccia al formaggio & wine...</td></tr>
</table>

SCIENTIFIC SCHEDULE

	Thursday, July 22nd		
	TH1_A	**TH1_B**	**TH1_C**
9.00 - 10.30	Patient flow (2) *Chair: Leonid Churilov* 1. **Maria Barton, Sally McClean, Lailt Garg, Ken Fullerton:** The economic benefit of thrombolysis for post-stroke community care - A simulation model 2. **Auður Friðriksdóttir**, **Leonid Churilov, Helen Dewey:** Modelling acute stroke thrombolysis pathways with Value-Focused Process Engineering 3. **Elena Gatti, Davide Luciani, Fabio Stella:** A Continuous Time Bayesian Network model for cardiogenic heart failure 4. **Martin Pitt:** Modelling the impact of extending the onset to treatment time of thrombolysis for acute ischaemic stroke from 3 to 4.5 hours	Advanced models *Chair: Vincent Knight* 1. **Amedeo Fossati, Marcello Montefiori:** Funding long term care 2. **Maura Francese, Marzia Romanelli:** Health Care in Italy:Expenditure Determinants and Regional Differentials 3. **Marina Resta:** On the financial health of Italian hospital facilitators: an empirical investigation through correlation-based networks 4. **Vincent Knight:** Measuring the Inefficiency of Choice	Simulation *Chair: Xie Xiaolan* 1. **Karen Cairns, Christine Allen, Adele Marshall:** Assessing different deployment plans of a colorectal screening programme through discrete event simulation 2. **Lene Berge Holm, Fredrik Dahl:** Simulating the impact of a 45% increase in patient volume at Akershus University Hospital 3. **Sule Kaya, Elcin Cakmak, Murat Günal, Kemal Sezen, Selcuk Onart:** Simulation Project for an Ear-Nose-Throat Clinic 4. **Jennifer Morgan, Susan Howick, Valerie Belton:** Considering Combining: Exploring a mixed approach of SD and DES to develop understanding within an Oncology Unit
10.30 – 11.00	***Coffee Break***		
	TH2_A	**TH2_B**	**TH2_C**
11.00 - 12.30	EMS (2) *Chair: Roberto Aringhieri* 1. **Saeedeh Ketabi, Sima Ajami:** Emergency Process Improvement By Lean At Kashani Hospital in Isfahan, Iran 2. **Julie Williams, Paul Harper, Jonathan Gillard, Vincent Knight:** Predicting Emergency Medical Service Demand in Wales using Singular Spectrum Analysis 3. **Erhan Kozan:** Optimisation of patient flows at emergency departments 4. **Roberto Aringhieri**, **Marco Gribaudo:** A Petri nets model for the analysis and the evaluation of an EMS.	Planning health services (3) *Chair: Walter Ukovich* 1. **Timothy Bolt, Steffen Bayer, Maria Kapsali, Sally Brailsford:** Lessons from Parallel SD Model-Building for National and Local Projects 2. **Thierry Chaussalet, Eren Demir, Salma Chahed, Farid Fouladinejad:** A tool for supporting Health Service Re-design decisions 3. **Maria Pia Fanti, Giorgio Iacobellis, Walter Ukovich:** A metamodelling approach to health care system management 4. **Christos Vasilakis, Christina Pagel, Steve Gallivan, David Richards, Martin Utley:** A software tool for assisting with the reconfiguration of the UK mental health services	Staff planning and scheduling *Chair: Patrick Soriano* 1. **Ilgin Poyraz Acar, Steven Butt:** Modeling nurse-to-patient assignments on a hospital unit 2. **Julien Crowe, Patrick Soriano:** Flexible personnel scheduling in Healthcare 3. **Paulien Out, Sandjai Bhulai:** Optimal personnel planning and admission scheduling in rehabilitation facilities 4. **Egbert van der Veen, Bart Veltman:** Do what must be done: no more, but certainly no less
12.30 – 13.45	***Lunch***		
	TH3_A	**TH3_B**	**TH3_C**
13.45 – 15.15	EMS (3) *Chair: Vito Fragnelli* 1. **Roberto Aringhieri, Maria**	Epidemiology & Disease modelling (4) *Chair: Martin Utley* 1. **Arjan Shahani:** A new approach	Home care *Chair: Federico Malucelli* 1. **Zdeněk Bäumelt, Libor**

	Elena Bruni: A new maximum reliability model for locating and dispatching ambulances 2. **Vito Fragnelli, Stefano Gagliardo:** Relocating ambulances at the end of rescue missions 3. **Valérie Bélanger, Angel Ruiz, Patrick Soriano, Roberto Wolfler Calvo:** A re-optimization approach applied to emergency medical services management 4. **Enrico di Bella**, **Marcello Montefiori:** Modelling activity and costs of health emergency department	for prevention and treatment of chronic diseases 2. **Martin Utley, Christina Pagel, Steve Gallivan, Nick Barber:** Modelling feedback effects in the adherence of patients to medication 3. **Sonia Vanderby, Michael Carter:** Modelling the Mental Health & Addictions "System" in Ontario, Canada 4. **Joe Viana, Sally Brailsford, Paul Harper, Veerkathy Harindra:** Evaluation of a composite System Dynamics, Discrete Event Simulation in a Sexual Health context	**Waszniowski, Přemysl Šůcha, Zdeněk Hanzálek:** Integrated Vehicle Routing and Rostering for the Home Health Care Services 2. **Emna Benzarti, Evren Sahin, Yves Dallery :** Operations management in Home Health Care: complexity factors and literature review 3. **Mario Lučić, Federico Malucelli, Maddalena Nonato, Alessandra Galletti, Caterina Montanari:** An optimization tool for planning health home care services 4. **Kian Seyed, Andrea Matta, Ettore Lanzarone**, **Mohsen Jafari:** Application of Semi-Markov Processes in Modelling Patient Duration of Stay in a Home Care Service
15.15 – 15.45	***Coffee Break***		
	TH4_A	**TH4_B**	
15.45 - 17.15	Logistics (2) *Chair: John Blake* 1. **John Blake, Matthew Hardy:** Modelling Red Cell Inventory and Ordering Policies 2. **Nicola Costantino, Mariagrazia Dotoli, Marco Falagario, Maria Pia Fanti, Agostino Marcello Mangini, Fabio Sciancalepore, Walter Ukovich:** Optimal design of distribution networks: an application to the hospital drug distribution system 3. **Alfonso Edgar, Xie Xiaolan, Augusto Vincent:** Discrete-event simulation of donor flow in blood components collection 4. **Yannick Kergosien, Christophe Lenté, Jean-Charles Billaut:** A Memetic algorithm for the design of hospital material flows	Planning health services (4) *Chair: Honora Smith* 1. **Sima Ajami, Saeedeh Ketabi, Sakine Saghaeinnejad Isfahani**, **Akram Sadeghian:** Improving the Medical Records Processes at Ayatolah Kashani Hospital in Isfahan, iran by Lean Management 2. **Cristina Azcárate, Fermín Mallor:** Integration of medical decisions into an Intensive Care Unit simulation model 3. **René Bekker, Paulien Out:** Clinical wards and the impact of elective admissions 4. **Jonathan Helm, Mark Van Oyen:** Design and Optimization of a Hospital Inpatient Bed Management System	
19.15 – Late	***Conference Dinner***		

SCIENTIFIC SCHEDULE

	Friday, July 23rd		
	F1_A	**F1_B**	**F1_C**
9.00 - 10.45	Patient flow (3) *Chair: Erwin Hans* 1. **Aleida Braaksma, Nikky Kortbeek, Gerhard Post, Kees Bijl:** Integral multidisciplinary rehabilitation treatment planning 2. **Erwin Hans, Nikky Kortbeek, Jasper Van Sambeek,Jelmer Kranenburg:** Feasibility of walk-in: a case study of CT-scanners 3. **Nikky Kortbeek, Maartje Zonderland, Richard Boucherie, Nelly Litvak:** The feasibility of walk-in: a formal analysis 4. **Kristian Rotaru, Andrzej Ceglowski, Kim Langfield-Smith:** Developing a patient-flow supply chain reference model to enhance performance management in healthcare 5. **Stefano Villa, Giuliana Bensa, Isabella Giusepi, Anna Prenestini:** A framework for the analysis of hospital patient flows: the results of an Italian benchmarking study	Quality *Chair: Lucas Delesie* 1. **Luc Delesie, Marc Haspeslagh, Kristof Eeckloo:** An inconvenient truth: bias in qualitative variables for OR modeling 2. **Alberto Franci**, **Caterina Gurrieri, Mario Corsi:** The assessment of hospital staff satisfaction 3. **Alberto Franci, Caterina Gurrieri, Mario Corsi, Greta Brardinoni:** Job satisfaction among social workers in the Marches Region in Italy 4. **Cinzia Panero, Anna Maria Murante**, **Giovanni Perucca:** The Patient needs and the answer General Practitioner: the Italian citizens experience. 5. **David Puga-Bolio:** Applying Problem Structuring Methods to Patient Safety Research: a case study of the implementation of the Patient Safety First Campaign	Software and Projects *Chair: Zbigniew Pasek* 1. **Barbara Canesi, Luca Corradi, Ornella Mazzetti, Ivan Porro, Nicola Rosso:** SurgiQ, waiting list management made easy 2. **Orla Treacy, Mark Turner:** Using Data Systems to improve Patient Centred Care 3. **Steven Burnell:** TeamFocus: Community Mental Health Services 4. **Salah Uddin Ahmed:** Private Public partnership: An experience sharing of Blue Star Social franchising program 5. **Georghe Bacioiu, Zbigniew Pasek:** Development of a Personalized Health Decision Support System
10.45 - 12.15	ORAHS Executive Meeting		
12.15 - 13.45	***Farewell Party***		

ABSTRACTS

PLENARY

Inside the US Health Care Reform

Gino Gumirato

Direttore Amministrativo ASL Roma and
Consultant of the Office of Management and Budget, Executive Office of the President USA

The United States of America launched their Health Reform on 23 March 2010. This policy was aimed to ensure equal access to sanitary care for millions of citizens.
What President Truman said in 1945 is by now well- known: "*People with low or moderate incomes do not get the same medical attention as those with high incomes. The poor have more sickness, but they get less medical care. People who live in rural areas do not get the same amount or quality of medical attention as those who live in our cities. Financial barriers in the way of attaining health shall be removed; the health of all its citizens deserves the help of all the Nation*."
It is well-known that he did not succeed in passing a health reform based on the establishment of a National Health Insurance.
The most recent history of the United States - the greatest health market in the world - confirms that before the reform took place, 46 million citizens had no health insurance, and a further 25,2 million were "underinsured": 71.2 million citizens (out of around 290) got precarious or no assured health assistance at all. Moreover, insurance companies are (or rather were) free to rescind the contracts with their clients when they contracted serious and/or chronic diseases – which, of course, would be expensive for them – and they might consider the contract not to be of "good value" at any time. They were able to prevent access to treatments or appliances they considered as too expensive at any time they chose to do so.
According to the data published by the World Health Organization (confirmed by the O.E.C.D. data), life expectancy in the United States is lower than in Italy, Japan, France, Canada and United Kingdom. Furthermore, it varies depending on the racial background of people: Afro-American women have a life expectancy of approximately 76.3 years, which is lower than that for white women (80.8) and women in general (80.4). Afro-American men have a life expectancy of 69.5 years, while that of white men is of 75.7 and men in general 75.2. An estimated 55% of the female population has health insurance, as do 61% of men. 45% of the population are uninsured Hispanic people, while uninsured Non- Hispanic White people make up about half of the percentage above mentioned. The insurance data confirms the discrimination connected with this group: 50% of people without an insurance have an annual income lower than $ 20.000; only 6% of uninsured people have a higher annual income.
The American Health Reform is therefore memorable and quite simply extraordinary, as it sanctioned the immediate removal of every potential oppressive clause from insurance contracts and thus signaled the beginning of the end for the discrimination against certain groups – something which has never been achieved before. The ten-year target is coverage for the 95% of the population; achieving 100% coverage is a difficult target due to the large number of illegal immigrants.
A wide system of obligations/sanctions will be set up in order to implement and realize the reform. This system will make it obligatory for all citizens and companies to get insurance. Families made up of four members with an income lower than $ 88,200 will receive increasing support in relation to their decreased income; in any case, the cost of the policy will not exceed 9.5% of the income (for a higher income) or 3% of income (for a lower income). The out-of-pocket contribution (i.e. direct payment made by the individual) will not exceed $ 5,950 a year for an individual or $ 11,900 for a family.
This amount of less than six thousand dollars has become a symbol for the reform: a citizen knows that getting insurance will no longer mean paying more than the fixed amount out of one's own pocket. In the past, millions of people lived in fear of economic crisis, while hundreds of thousands of people and families actually went bankrupt because of the cost of sanitary services.
Companies will receive a lot of tax reductions. The ones with less than 50 employees (and in some cases with less than 25 employees) will have access to subsidies up to 50% of the full cost of policies for their own insured staff. Children will be allowed to be part of the family insurance until the age of 26 (before the reform the maximum age was 18), and the coverage of medicine from the Medicaid program will be increased.
The growing economic difficulties for companies were the second serious reason to urge a reform. In fact

around 80% of the American PIL (GNP) is produced by small companies (the ones with less than 50 employees) and these companies were the ones who had to pay insurance costs for their employees which grew higher and higher year by year. For the very same insurance coverage, a small company used to pay up to 30% more than a larger firm (i.e. one with more than 50 employees): a by now unbearable gap in the world market.

The "free health market" and "the independence of the subject offering services" from "the subject who chooses them" determine the success or failure of a hospital; according to the supporters of this model, every citizen "is free" to be hospitalized where he/she wants, to take the medicines he/she desires, to go into the retirement home he/she likes and, in so doing, to determine the success or failure of the structure of his/her choice. This model did not succeed in the United States (and also in other areas of the world) for a simple reason: the amount of request for sanitary services is extremely variable, and whatever quantity of sanitary services is put on the market is consumed. Individual suppliers of these services tend to maximize their production, regardless of both the suitability of the treatment offered and of its integration. The consequences are extraordinarily high prices (twice as high as in European countries), an uncontrolled increase in the number of treatments (meaning that citizens are obliged to go from town to town and from state to state to search for the best treatment), no access at all to treatment for millions of people (71.2 million as already mentioned above),as well as companies inability to afford insurance costs.

Therefore the historical model idealized by American republicans caused the risk of a serious crisis in the country's economic system, not the health system.

The American reform was passed in Parliament not only to provide millions of Americans with the possibility to receive treatment, but also to preserve the economic system on the whole. Those companies obliged to pay ever increasing insurance costs for their staff were no longer competitive on the world market. The difference in business costs due to insurance costs was unequalled in the rest of the world: the system would "collapse" in the next fifteen to twenty years.

President Obama has said many times that "*It is not correct to assume that the reform is a problem for America; the reform is part of the solution for the problems America has got*". The need to reduce the costs for companies also corresponds to the need for a reduction of the Federal Government's structural deficit. The three historical paradoxes of the American Health System, surmountable in the next ten years, were: 1) the discrimination of millions of people regarding access to treatment, 2) excessively high costs both for the citizens and for companies, unacceptable on a globalized market, and 3) the sky-high deficit of the Federal Government. The financial coverage of the reform (an estimated 940 billion dollars over the next ten years) must be considered with this in mind, even if we know by now that at the end of the ten years the savings for the federal funds will amount to approximately $ 1,300 billion. The reform will ensure an almost full insurance coverage for the population, obviously integrated with the measures taken regarding the increase of quality and suitability of the supplied services (especially regarding the Medicaid program). The consequence will be an immensely lowered cost of the country's Health System.

At the beginning the main instrument chosen to implement the reform was the so- called "public choice", but this one was not taken into consideration in the last legislative version. The first hypothesis was to create a real "public insurance": citizens would be free to choose the insurance they wanted and, if they could not find it, have the opportunity to choose a public solution. A double level of "digital insurance market" has been provided for in the final version: all data and information about the country's insurance companies are available to citizens. Insurance companies cannot have discriminatory or oppressive clauses nor are they allowed to stop treatment in any case. A central agency (a federal, second level one), has the task of managing the information flow for the entire country ($ 16 billion have already been settled for digital information).

The world-wide relevance of the reform is already obvious now, more than a year since the Commission, I had the honor to take part in, started its work and only a few weeks after the launch of the reform itself: China and India froze their initiatives for one year, waiting for America; South Africa is grappling with the first great hypothesis of a National Health System. Delegations from Japan, South Korea, Australia (but also Canada, France, Germany, Great Britain, etc…) are wondering what the development model of Health and Welfare will look like in the third millennium.

The merit of the United States was to start learning from their own mistakes and to put their citizens' health at the centre of the country's progression. The quantity and quality of treatment and assistance that the country is able to offer has a bearing on the economic situation of billions of people: no country in the world, neither the United States, nor China or India or Russia, can successfully debate their own economic future if they do not at the same time take into consideration their health needs and the resources they can use. These resources are an indispensable development factor. I would call it the "Obama factor".

Modelling the care of younger people

SYMPOSIUM TH3

Pediatric palliative care organization simulation model

Giada Aspergh[1], Paola Facchin[1], Anna Ferrante[1],
Giorgio Romanin-Jacur[2], Laura Visonà-Dalla-Pozza[1]

[1] *Epidemiology and Community Medicine Unit, Department of Paediatrics University of Padova, Italy*
epi@pediatria.unipd.it

[2] *Department of Management and Engineering, University of Padova, Italy*
romjac@dei.unipd.it

Pediatric palliative patients are children suffering for incurable pathologies which cause them a lot of problems, to whom health services try to give a life the most close to a normal one. Only recently they have been accepted as specified patients needing qualified care. They present a wide pathologies spectrum, a large lifetime distribution and frequent changes in their conditions. The assistance aims at obtaining a clinical equilibrium permitting an acceptable life, utilizing an assistance care network including: hospital acute and intensive departments (able to supply non specific cares), hospices (able to supply specific cares), territorial structures (able to supply either specific integrated medical and social home assistance, when possible, or alternatively simple home care). An assistance plan may be set up for every patient, possibly supported by different structures in different time intervals, based on regional assistance policy, patient conditions and resources at disposition. It is necessary to consider that pediatric palliative patients compete with ordinary pediatric patients for admissions to hospital departments. From statistics supplied by hospital and territorial information systems it is possible to obtain the new patients arising rate, the length of stay distributions in all assistance structures, the length of life distributions of all patients types and the compulsory transitions among the various structures, when present. Based on such parameters, we build up a discrete stochastic simulation model describing the assistance network and reporting patients' movements among the structures in correspondence of different assistance policies, also in case of evolving assistance organization. The scope is to evidence all lacks in satisfying users' requests and suggest possible adjustments or new investments. The model has been applied to an actual territorial region but may be extend to other realities by suitably adapting structural and behavioural parameters.

Keywords: Planning health services, Resource allocation in health care, Simulation, Health providers, Patients.

SYMPOSIUM TH3

Where Is the Profit in Rare Diseases Research?

Michela Chessa[1], Stefano Gagliardo[2]

[1] *University of Milano, Italy*
michela.chessa@unimi.it

[2] *University of Genova, Italy*
gagliardo@dima.unige.it

The research program on treatment of rare diseases often finds obstacles. The monetary profit which can be obtained may be considered not high enough by pharmaceutical companies to justify the relevant amount of money needed. Moreover, the possible human benefits, based on the number of people whose life can be saved or made better, do not involve as many people as a common disease. Government intervention can be

important: it may act as a mechanism designer, finding a mechanism based on funds, fiscal reduction and other measures which may provide incentives for companies to increase research on these diseases.

Keywords: Resource allocation in health care, Decision theory, Rare diseases, Orphan drugs.

SYMPOSIUM TH3

Applying OR to the problem of paediatric heart transplant waiting lists and 'bridging' technologies

Sonya Crowe[1], Christina Pagel[1], Kate Bull[2], Matthew Fenton[2], Christos Vasilakis[1], Steve Gallivan[1], Martin Utley[1]

[1] *Clinical Operational Research Unit, University College London, UK*
{sonya.crowe, c.pagel, c.vasilakis, steve.gallivan, m.utley}@ucl.ac.uk

[2] *Great Ormond Street Hospital for Children, London, UK*
{BullC, FentoM}@gosh.nhs.uk

In the UK, children suffering from serious cardiac conditions that would benefit from heart transplantation are placed either on an urgent or non-urgent donor recipient waiting list, depending on the severity of their condition. At present, children are dying on these waiting lists and yet some donor organs are being refused due to a lack of a suitable recipient. "Bridging" technologies can be used to stabilise some of these precarious children, lengthening the window of opportunity for suitable donor hearts to become available for them and potentially increasing donor heart usage. However, bridging technologies, which may require prolonged patient stay in a cardiac intensive care unit, come at an enormous financial cost and are burdensome for the patients and families involved. In forming policy regarding bridging, there is a balance to be struck between the time-related risks of death or complications with and without bridging and the opportunity cost associated with the use of intensive care beds. Furthermore, bridging raises questions regarding the way in which children on both waiting lists should be prioritised when a suitable heart becomes available.
We have worked in collaboration with Great Ormond Street Hospital, London to explore some of the key relationships and dynamics of this problem using an analytical mathematical model based on queuing theory.

Keywords: Transplant waiting list, Bridging technology, Queuing theory, Health providers, Patients.

SYMPOSIUM TH3

Perinatal Assistance Network Planning Via Simulation

Paola Facchin[1], Anna Ferrante[1], Elena Rizzato[1],
Giorgio Romanin-Jacur[2], Laura Salmaso[1]

[1] *Epidemiology and Community Medicine Unit, Department of Paediatrics University of Padova, Italy*
epi@pediatria.unipd.it

[2] *Department of Management and Engineering, University of Padova, Italy*
romjac@dei.unipd.it

Consider a geographical region where population is distributed in health districts, and there exists a neonatal care network, which includes birth centres at three levels, apt to supply respectively basic assistance, mild pathology care and neonatal intensive care. The high medical specialization and special instruments required for neonatal intensive care oblige to link large catchment areas to few suitable facilities. Besides, a large group of newborns, in physiological or mildly pathological conditions, requiring respectively basic assistance and mild pathology care, can be cared at less specialized facilities and by less expert staffs: more facilities, spread on the territory, are convenient to contain the distances between the facilities and the areas they serve. Wherever a higher level facility is placed, all lower level facilities are present too. Each mother-to-be is admitted to a facility characterized by the level corresponding to the expected newborn conditions; newborn transfers from a lower to a higher-level facility are urgently effected whenever the newborn conditions reveal to be worse than expected or worsen. Each district has a demand, in admissions per year, for each of the three perinatal care levels, obtained from recent statistics. Each facility has its capacity, i.e., the amount of patients who can be simultaneously admitted: the capacity of the third level is given by the number of ventilated incubators and the capacity of the second level by the number of incubators; the capacity related to all three care levels combined is the number of beds available for the mothers. A simulation model describing mothers and newborns movements from districts to birth centres and among centres has been built up, with the aim of revealing lacks and inadequacies in the assistance network and of obtaining useful suggestions about suitable network resizing in order to improve service quality and reduce trouble due to distance.
Keywords: Planning health services, Resource allocation in health care, Simulation, Health providers, Patients.

SYMPOSIUM TH3

Workforce modelling in paediatric gastroenterology

Paul Forte

The Balance of Care Group, UK
Paul.forte@balanceofcare.com

In recent years there has been a growing emphasis on the need for collaboration across different agencies and professional care groups in the organisation and provision of health services for children. This is driving the development of new care pathways which, in turn, leads to changes in the demand for different care professional groups. Understanding what these potential workforce changes might be - and how they might be met – has particularly important consequences for resource management. The *Balance of Care* approach can be used to respond to these new demands as its scope encompasses both data modelling and planning workshops directly involving the clinicians.
This is done by establishing appropriate client group categories and focusing on their care needs. For any individual category there will be a range of potential appropriate care 'options' which will impact on resource requirements. Workforce implications are particularly important here.
Working with local health and social care professionals through a series of workshops the *Balance of Care* model enables extensive - and fast - policy testing to indicate potential effects of different care strategies. The approach helps people to focus on relevant questions to ask about service development, target populations and potential resource consequences and, in this way, helps to structure lines of enquiry and prioritise the use of scarce resources.

Keywords: Care pathways, Workforce resource planning, Spreadsheet modelling, Local health economy, Hospitals, Clinicians, Managers.

Modelling the care of older people

SYMPOSIUM W1

The Balance of Care approach: modelling complexity in services for older people

Paul Forte, Tom Bowen

The Balance of Care Group, UK
Paul.forte@balanceofcare.com

References to the Balance of Care model go back almost 40 years, yet it remains highly relevant and applicable today. So what accounts for its longevity? This presentation briefly outlines the structure of the approach and reviews its development and application over the years. The model is based on a description of supply and demand elements significant to any given patient group, and the specification of alternative care packages. Identifying sufficient data to calibrate the model, together with ways to handle the data and engage decision makers across a local health and social care economy have been central to its development.
Recent applications in the fields of dementia and telecare are presented as examples of the overall approach. From an operational research perspective there are important lessons to be drawn about the development and application of models in general; in particular, managing the interface between model and user.

Keywords: Services for older people, Health and social care, Spreadsheet model, Decision support system, Service commissioners and providers, Clinician/ manager interface.

SYMPOSIUM W1

Longitudinal area-databases for monitoring and analysis of the care-of-the-elderly system in Sweden

Mårten Lagergren

Stockholm Gerontology Research Center, Sweden
marten.lagergren@aldrecentrum.se

Purpose: To study the process of aging and the development of needs for aged care and services and how these needs are met by formal and informal care in different areas in Sweden
Design and method: The longitudinal survey SNAC – Swedish National study on Aging and Care- started data collection in February 2001 in four different areas in Sweden. The study is divided into two parts: the population and the care services part. In the population part a large, representative panel of elderly in different age cohorts is followed over time to record and describe the ageing process from different aspects.
In the care and services part there is a corresponding systematic, longitudinal, individually based collection of data concerning the provision of care and services together with the functional ability, specific health care problems and living conditions of the recipients living in the area. This data collection makes it possible to follow needs and care provision over time and in this way different flows between modes of care and levels of disability can be analysed.
Results: As an example data taken from the Kungsholmen district in Stockholm, combined with official death registers, have been used to determined one-year mortality as a function of disability level and mode of long-term care. Moreover, mortality per age-group and gender has been compared between care recipients and the rest of the elderly population. The results show that there is very clear connection between disability

level and mortality. Per age-group mortality is significantly higher for care-recipients than for the rest of the elderly population – and especially so for those in institutional care.
Implication: The results can be used in planning the long-term care of elderly persons. Also the differences in mortality between modes of care raises important questions regarding quality of services and of life.

Keywords: Mortality, Disability, Longitudinal survey, Planning of aged care facilities.

SYMPOSIUM W1

Modelling the determinants of resident satisfaction in aged care facilities

Duncan Boldy

Centre for research on Ageingent, Curtin University, Australia
d.boldy@curtin.edu.au

Purpose: The aim was to identify the important factors influencing residents' satisfaction in residential aged care and to provide a better understanding of their inter-relationships.
Design and Methods: A cross-sectional survey design was used to collect required information, e.g., resident satisfaction, resident dependency levels, staff satisfaction, etc. A stratified random sampling approach was utilized to select facilities. All residents satisfying the selection criteria (i.e., understand English, sufficiently cognitively competent, sufficient energy level to participate in the survey and lived in the facility for more than 4 weeks) and all care staff were invited to participate. A total of 996 residents and 895 staff from 62 facilities (36 hostels and 26 nursing homes) provided all required data. Structural equation modeling was used to examine the inter-relationships among three sets of contributing factors, related to (i) the facility, (ii) the staff and (iii) the residents, separately for nursing home and hostel residents.
Results: Overall fits of the models to the data were satisfactory for both nursing home and hostel. This study has revealed that staff satisfaction plays a crucial and central role in determining resident satisfaction in nursing homes, whilst it has less impact in hostels. The provision of more care hours has only a small, yet positive, impact on resident satisfaction. Larger facility size has a negative impact on resident involvement. Older residents were found to be more satisfied with staff care.
Implication: The results provide a comprehensive understanding of what influences resident satisfaction. By accounting for important factors identified by residents, a resident-focused care model can be developed and implemented, leading to aged care residents being better served and more satisfied.

Keywords: Planning care services, Structural equation modelling, Managers of aged care facilities.

SYMPOSIUM W1

Patient-centered care and efficiency in nursing homes

Giulia Garavaglia[1], Emanuele Lettieri[1], Tommaso Agasisti[1], Cristina Masella[1], Salvatore Silvano Lopez[2]

[1] *Department of Management, Economics and Industrial Engineering, Politecnico di Milano, Italy*

{giulia.garavaglia, emanuele.lettieri, tommaso.agasisti, cristina.masella}@polimi.it

[2] *Local Health Unit Milano 1, Italy*
silvano.lopez@aslmi1.mi.it

This study investigates the managerial and contextual factors affecting the delivery of nursing homes' primary processes (health, nursing and residential services). In particular the implications in terms of quality for patient-centered care are investigated.
Using Data Envelopment Analysis (DEA), we assessed the efficiency of 40 nursing homes in Lombardy for a three-years period (2005-2007). Lombardy is a very interesting setting, as the health care industry is organized as a quasi-market, in which the public authority "buys" health and nursing services from independent providers - establishing a reimbursement system for this purpose. Our DEA model employs 5 variables, in part selected from the literature and in part from the debate with the institutional experts. In particular, the quality of both the nursing and residential services have been measured with two distinct output variables (i.e. the extra nursing hours and the residential charges).
In a second-stage analysis, we apply Tobit regressions and the Kruskall-Wallis tests of hypothesis to the efficiency scores, in order to define what are the factors that affect the trade-off between efficiency and quality for patients.
The DEA results and the further analysis reveal that the main factors affecting efficiency are (i) the policy of the health and nursing costs containment and (ii) the ownership (private houses outperform their public counterparts). Moreover, we found that efficiency is positively related to the quality of care. The results highlight that the labor price is negatively related to the quality of care. Lastly, even though the public institutions are less efficient than the private ones, the results suggest that there is an improvement over the period, suggesting that competition is benefiting efficiency and quality of care. These results are useful for both health regulators and nursing homes managers to monitor and improve the efficiency and quality of patient-centered care over the time.

Keywords: Quality, Efficiency, Data envelopment analysis, Nursing homes.

SYMPOSIUM W1

Assessing nursing home costs: a patient-centered perspective

Angela Testi, Enrico Ivaldi, Elena Tanfani

Department of Economics and Quantitative Methods, University of Genova, Italy
{testi, etanfani}@economia.unige.it

The paper focuses on the services delivered in nursing homes, that are facilities providing services of different kind - medical, rehabilitative, psychological - to meet physical and mental disabilities in the elderly who are either physically or mentally unable to live independently. Residents are, therefore, provided not only with medical treatment, but also with rooms, meals and daily living assistance. The services we are addressing are at the same time health and social as they stem from the particular frailty condition of the elderly people implying they are not self-sufficient, though on different degrees. Moreover, their disability in Activity Daily Living (ADL) is sometimes accompanied by senile dementia.
The specific aim of the presented case-study is to relate residents' need with resource absorption, in particular personnel requirement. Results can help in: i) evaluating the "standard" cost of the guaranteed benefit package to meet the elderly frailty, according to need (a patient-centered point

of view); ii) giving some insight about how a Prospective Payment System (PPS), based on the case mix adjustment could be implemented.
Data were collected in the largest public nursing home in Genova (about 500 beds). Patients admitted are different with respect to their physical and mental impairment and they are not self-sufficient in different degrees. They, consequently, require an appropriate service mix delivered by a multidisciplinary team, that includes physicians, nurses, social operators, physical therapists and so on. Three methodological instruments are used. Multidimensional evaluation is intended to predict the degree of disability. Data Mining procedures are used to detect homogeneous classes with respect to costs. Factorial analysis is used to identify the required kind of assistance and, therefore, the appropriate mix of personnel skills required meet patient needs.

Keywords: Patient classification, Data mining methods, Factorial analysis, Patients, Nursing homes.

Patient flow (1)

M1_A

DRG-based resource allocation and patient flow management in hospitals

Daniel Gartner, Rainer Kolisch

TUM School of Management, Technische Universität München, Germany
{daniel.gartner, rainer.kolisc}@wi.tum.de

We consider the problem of planning the flow of elective patients in a hospital considering scarce resources such as beds, diagnostic devices and the operating theatre. We assume that patients have been admitted to the hospital and that for each patient the clinical pathway and the DRG are given. The clinical pathway of a patient defines the operations to be performed, the required resources and precedence relations between the operations. The DRG and the length of stay determine the revenue the hospital will receive for a patient. We model the problem of scheduling the patients subject to the scarce hospital resources with the objective of maximizing the DRG-based revenues of the hospital. This problem is closely related to admission planning but instead of deciding on the number of patients for fixed schedules we decide for a fixed number of patients about the schedule (patient flow) of each patient. To this end we model the problem as a multi-project resource-constrained project scheduling problem with minimum and maximum time lags. The model is implemented in OPL and solved with CPLEX. We will provide a case study and present first computational results. Furthermore we will discuss extensions of the model such as stochastic durations of the operations and the maximum number of ward transfers for a patient.

Keywords: Resource allocation in health care, Patient flow management, Integer programming, Health providers.

M1_A

Modelling patient length of stay in Mexican public hospitals

Maria de Lourdes Guzman Castillo, Sally Brailsford, Honora Smith

School of Management, University of Southampton, United Kingdom
{mdlgc106, S.C.Brailsford, Honora.Smith}@soton.ac.uk

According to the National Health Plan 2007 – 2012 the main problem of the Mexican national healthcare system in terms of quality and efficiency is the enormous heterogeneity that exists among the main service providers.
In terms of length of stay in hospitals, it is found that the average length of stay for same surgical procedures or diagnosis varies considerably across different healthcare providers. E.g. the average length of stay in a hospital for appendectomies under 60 beds at the IMSS is 6.5 days against 3 days in hospitals in the State Services. This variation could be explained by the presence of other internal and external factors affecting the service.
More complex and sophisticated tools to understand length of stay are needed to help decision makers to develop a common national action plan to improve quality and efficiency of services.
But it is not only at the national level where more complex tools are needed. Managers and medical staff at local hospitals are interested on the internal factors which affect the length of stay of individuals at hospitals e.g. characteristics of patients: age, sex, diagnosis, the presence of comorbidities, pathological history, pathological family history, etc.

The aim of this research is to develop a statistical model of the length of stay which captures the true variability of the system and incorporates characteristics, attributes, and other internal and external factors related to the patient and the length of stay, at both, national and local level. Data from two public hospitals in the same district will be discussed to illustrate the heterogeneity and complexity of the system.

Keywords: Length of stay, statistical analysis, systems, patients.

M1_A

Clinical Pathways: A dual approach to implement and assess Clinical Pathways

Yasar A. Ozcan

Department of Health Administration, Virginia Commonwealth University, USA
Ozcan@vcu.edu

Clinical pathway is a concept that promotes variance reduction in delivery of health care. To achieve this, health care providers must improve efficiency in the use of resources while completing delivery of care in time with expected achievements in quality. Implementation of the clinical path ways require identification of tasks of a care delivery for a specific disease by a multi-professional team including physicians, nurses, various therapists and/or health technologist and so on.
Implementing clinical pathways for a disease where patient and multi-professional care delivery teams can be conceptualized as an integrated project with many tasks. Hence, the management of the care delivery tasks in time nicely fits to one of the operations research tools, project management. In order to organize the integrated care delivery tasks as project, all medical specialties and professions that contribute to process must be involved in development and implementation of this process.
Clinical practice variation which increases resource consumption as well as quality mishaps can be assessed using data envelopment analysis (DEA). More specifically, one can identify practice styles for a specific disease for group of health care providers, and assess the impact when the practices use most preferred style of clinical work. This is done in two stage DEA analysis using weight restricted/cone ratio models, where at the first stage all providers assessed in current practice, then preference equations imposed through weight restrictions (forming various cones) to assess potential resource savings if certain practices (i.e., clinical pathways) followed.
Furthermore, once the clinical pathway processes are implemented and functioning, practice variation can be measured before and after the implementation using Malmquist method to demonstrate the improvements.

Keywords: Clinical pathways, Data envelopment analysis (DEA), Project management, malmquist, Health care providers.

M1_A

Long Term Planning for COPD in Derbyshire County PCT

Dave Worthington[1], Philip Worrall[2]

[1] *Department of Management Science, Lancaster University, UK*
d.worthington@lancaster.ac.uk

[2] *School of Computer Science, University of Westminster, UK*
philip.worrall@nhs.net

This talk focusses around a Masters student project undertaken for Derbyshire County Primary Care Trust to build a prototype planning model that would help the trust estimate the future burden of Chronic Obstructive Pulmonary Disease (COPD). Population projections obtained from the Office of National Statistics (ONS) were used in conjunction with national smoking trends to estimate a baseline number of people at risk of having COPD in each year from 2009 to 2031. These figures were then adjusted to reflect the group the coal mining history of the county, and total numbers of patients flowing through the COPD care pathways each year were estimated using available data and expert opinion. The prototype model was built in Excel and results from the model showed that the cost of disease has a potential to increase 44% by 2031, with over 50% of the cost of the pathway being attributed to admissions to secondary care and crisis management.
In many respects this project is a 'typical' OR contribution to tackling one of the major health care challenges associated with growing elderly populations. Given the importance of these issues the question is posed of what else OR modellers might be able to offer.

Keywords: Long term planning, Patient flow modelling, Patient pathways, County level, Case study.

Epidemiology & Disease modelling (1)

M1_B

A deterministic scheduling model in epidemic's control with multiple resources

Nikolaos Rachaniotis, Tom Dasaklis, Costas Pappis

Dept. of Industrial Management, University of Piraeus, Greece
{nraxan, dasaklis, pappis}@unipi.gr

Available resources to tackle an epidemic infection are usually limited, while time and effort required to control it are increasing functions of the starting time of the containment effort. The problem of scheduling limited multiple, identical or non-identical, resources employed in parallel, when there are several infected areas, is considered. The epidemic's rate of spread is modeled as a deterministic function of time. The problem is treated using the concept of deteriorating jobs, i.e. the model represents increasing loss rate as more susceptibles become infected, and increasing time and effort needed for the epidemic's containment.

Keywords: Resource allocation in health care, Disease policy modelling, Integer programming, Heuristics, System (Region & National).

M1_B

Reducing HIV-related Acute Care Admissions through Drug Treatment Program Expansion

A. R. Rutherford[1], Pouya Bastani[2], Bojan Ramadanovic[3], Krisztina Vasarhelyi[4], Rolando Barrios[5]

[1] *IRMACS Centre and Dept. of Mathematics, Simon Fraser University, Canada*
sandyr@irmacs.sfu.ca

[2] *BC Centre for Excellence on HIV/AIDS, Vancouver, Canada*
pbastani@irmacs.sfu.ca

[3] *IRMACS Centre, Simon Fraser University, Canada*
bramadan@irmacs.sfu.ca

[4] *BC Centre for Excellence on HIV/AIDS and Faculty of Health Sciences, Simon Fraser University, Vancouver, Canada*
kvasarhelyi@irmacs.sfu.ca

[5] *BC Centre for Excellence on HIV/AIDS, Vancouver, Canada*
rbarrios@cfenet.ubc.ca

Highly active antiretroviral therapy (HAART) reduces the incidence of AIDS-defining illnesses among HIV-positive patients. The three AIDS-defining illnesses which most often lead to hospitalization are pneumocystis carinii pneumonia (PCP), mycobacterium avium complex (MAIS), and candidadis of esophageal, bronchi, trachea or lungs (CANDIDA). Approximately 90% of patients with these AIDS-defining illnesses require hospitalization. Furthermore, approximately 30% of patients with PCP require admission to the intensive care unit (ICU) and 5% of patients with CANDIDA and MAIS require admission to the ICU.

In Vancouver, HAART and physician care are provided to the HIV-positive community through a Drug Treatment Program (DTP). A model is developed to examine the extent to which expanded access to HAART reduces hospitalizations for AIDS-defining illnesses. The model is a hybrid model in which the DTP is modelled using a compartmental model consisting of people susceptible to HIV infection, HIV-positive patients not yet in the DTP, patients in the DTP who are being treated with HAART, and patients who have initiated HAART treatment, but whom are no longer adherent. This model is coupled to a queue network model of the hospital, which incorporates both general medical beds and ICU beds.

The model is applied to an inner-city hospital in Vancouver, which cares for the patient population with the highest HIV incidence in Canada. It is shown that if the annualised rate of direct admissions —as opposed to through hospitalization—to the DTP is increased from 0% to 30% of the HIV-positive population, then the non-ICU bed utilization for AIDS-defining illnesses is expected to drop from 3012 bed-days/year to 1195 bed-days/year. Furthermore, ICU bed utilization is expected to drop from 411 to 141 bed-days/year. The implications of this model for making the economic case for expanded access to HAART will be discussed.

Keywords: Disease policy modelling, Compartmental model, Queue network, Simulation, Health system, Health providers.

M1_B

A deterministic model to assess the impact of circumcision and other interventions in countries with generalized HIV epidemic. An application to Botswana.

Christian Viladent[1], Ann van Ackere[2]

[1] *School of Business and Technology, Webster University, Geneva, Switzerland*
viladent@webster.ch

[2] *HEC, University of Lausanne, Switzerland*
ann.vanackere@unil.ch

Recent studies in African countries report a protective effect of male circumcision (MC) toward HIV transmission. Based on an extensive literature review, we developed a generic deterministic model, in order to evaluate the impact of male circumcision (MC) and other interventions against HIV/AIDS in developing countries where the HIV epidemic has generalized. The model also includes a dynamic life expectancy calculator.

The model is calibrated using Botswana as a case study. We have evaluated the programme which was initiated in 2008 in Botswana and consisting of 80% of adult men circumcised by 2012. This circumcision campaign takes place in parallel to the current anti-retroviral treatment (ART). The socio-economic impact is

assessed from a social welfare point of view, using disability adjusted life years (DALY). Assuming a protection level of 50% with circumcision, a cost per MC of $85 and a time horizon of 2025, our model indicates that 5.6 million DALY could be averted at a total cost of $2.37 billion, thus a cost of $423 per DALY averted. In addition, we have tested three additional scenarios: extensive boy circumcision (BC), treating sexually transmitted diseases (STD) and "abstain, be faithful or use condom" (ABC) campaigns. We assume one ABC campaign in 2009 and one in 2010 at a cost of $143,600 each. The cost for STD treatment is assumed at $317 per person and the cost per BC $10 plus $10 to access the health care facility. Our results indicate that MC is more efficient than STD, ABC and BC with a cost per DALY averted of respectively, $423, $507, $525 and $1071.
We conclude that MC, STD and ABC interventions lead to cost-efficient results in term of HIV prevention. The results from boy circumcision are not surprising as it takes one generation to observe the results of this intervention.

Keywords: Decision support systems for health care, System dynamics, Policy model, System (Region & National).

M1_B

Simulation model for the evaluation of HIV vaccine intervention

Israel T. Vieira[1], Valter de Senna[2]

[1] *School of Mathematics, Cardiff University, UK*
israel@itvieira.org

[2] *Computer Modelling Dept., Senai-Cimatec, Bahia, Brazil*
valter.senna@gmail.com

The Human Immunodeficiency Virus (HIV) is having a serious impact on many societies and economies. HIV kills people at the most productive time of their lives and despite the success of the Highly Active Anti-Retroviral Therapy (HAART) in slowing down the disease progress, no cure is in sight. Additionally, HAART is an expensive treatment for all but the wealthiest societies, the development of preventive HIV vaccine is the best hope of controlling the HIV pandemic. In December 2009, the RV144 vaccine trial results showed for the first time efficacy in preventing HIV-1 infection in humans, with a lowered rate of HIV infection of 31.2% ($p = 0.04$).
It has long been recognised that the structure of social networks plays an important role in the dynamics of infectious disease propagation. The dynamics of HIV transmission is a highly complex process and varies enormously. Not only is the HIV epidemic dynamic in terms of treatment options, prevention strategies and disease progression, but also in terms of sexual behaviour which is widely diverse and deeply embedded in individual desires, cultural relationships, and the enormous social network where we all live.
We present experimental results on effective options for immunisation of a population or group of individuals using the HV144 HIV vaccine. The results show that at the 31.2% efficacy of the RV144 trial, this vaccine can reduce the HIV transmission if coverage is high, while a hypothetical 75% efficacy vaccine could markedly reduce the HIV pandemic with relatively low coverage. In any case, vaccine intervention must go alongside education and a wide range of effective prevention programmes. Those who receive the vaccine must understand that their risk of contracting HIV infection has lessened but has not vanished.

Keywords: Disease policy modelling, Small-world networks, Simulation, System (Region & National).

Appointment scheduling

M2_A

Exact and Sampling-Based Methods for Appointment Scheduling with Discrete Random Durations

Mehmet A. Begen[1], Retsef Levi[2], Maurice Queyranne[3]

[1] *Ivey School of Business, University of Western Ontario, Canada*
mbegen@ivey.uwo.ca

[2] *Sloan School of Management, MIT, USA*
retsef@mit.edu

[3] *Sauder School of Business, University of British Columbia, Canada*
maurice.queyranne@sauder.ubc.ca

We determine optimal appointment schedule for a given sequence of jobs (e.g., surgeries, physician appointments) on a single processor (e.g., operating room, physician), to minimize the expected total underage (idle-time of the processor) and overage costs (waiting time of jobs and overtime of the processor) when each job has an integer random processing duration given by a joint discrete probability distribution. Our model can handle a given due date for the total processing (e.g., end of day for an operating room) after which overtime is incurred and, no-shows and some emergencies. In the case of unknown duration distributions, we determine bounds on the number of independent samples required to obtain provably near-optimal solution with high probability. We believe that our framework is sufficiently generic so that it is portable and applicable to many appointment systems in healthcare.

Keywords: Appointment scheduling, Operating room/examination planning, Discrete-convexity algorithms, Sampling-based analysis, Hospital, Physician.

M2_A

A Generic Outpatient Appointment System Simulation Model

Arda Ceylan[1], Murat M.Günal[2]

[1] *Institude of Naval Science and Engineering, Turkish Naval Academy, Tuzla, Istanbul, Turkey*
aceylan@dho.edu.tr

[2] *Department of Industrial Engineering, Turkish Naval Academy, Tuzla, Istanbul, Turkey*
mgunal@dho.edu.tr

One of the operational research methods used in improving processes in hospitals is Discrete Event Simulation (DES). DES is applied in many parts of hospitals such as Emergency Departments, operating theatres, inpatient facilities and outpatient clinics. Although DES is a popular method, its use is still limited due to a number of reasons. In a DES project, the modellers tend to build their own models, either from scratch or re-use their previously built models. The use of someone else's model is very rare. From "re-inventing the wheel" point of view, building generic DES models should have more emphasize in healthcare simulation community. In this study, we present a generic outpatient Appointment System (AS) simulation model. As is well known, waiting time performance of outpatients, pre-admission phase, is linked to the AS system. This generic model is designed to test the waiting time performance in an outpatient clinic under different AS rules. One of the motivations behind this modelling work is a discussion in the literature on the

effects of appointment and patient sequencing rules on performance. This model is intended to be used for assessing these effects. The model also incorporates unplanned patient arrivals to the clinic and therefore be used to evaluate the effects of stochastic arrivals on appointment patients. We demonstrate a number of experiments for fictional scenarios where the effects of variability in unplanned patient arrivals are assessed.

Keywords: Performance measurement/evaluation in health care, Simulation (Discrete Event), Patients.

M2_A

Week Hospital Inpatient Flow Management

Domenico Conforti, Francesca Guerriero, Rosita Guido

Dipartimento di Elettronica, Informatica, Sistemistica, Università della Calabria, Italy
mimmo.conforti@unical.it, {guerriero, rosita.guido}@deis.unical.it

Week Hospital is an innovative inpatient health care organization and management, by which hospital services are planned in advance and delivered on week-time basis for elective patients. In this context, a strategic decision making problem is related to the optimal clinical management of patients, and, in particular, to the implementation of efficient and effective admission and scheduling procedures, by tackling different requirements (e.g., beds' availability, diagnostic resources and treatment capabilities). The main aim is to maximize the patient flow, by ensuring that for each admitted patient all the required clinical services are delivered during the week.
In this work, the optimal management of Week Hospital patients is considered, by developing and validating an innovative integer programming model, based on clinical resources allocation and beds utilization. In particular, the proposed optimisation model aims at scheduling, in an effective and efficient way, Week Hospital patients' admission/discharge, possibly reducing the length of stay on the basis of an available timetable of clinical services. The performance of the model is evaluated, in terms of efficiency and robustness, by considering real data coming from a Week Hospital Rheumatology Division. The experimental results seem satisfactory and demonstrate the effectiveness of the proposed approach.

Keywords: Resource allocation in health care, Patient flow managemen, Integer linear programming, Health providers, Patients.

M2_A

Application of Genetic Algorithm on Outpatient Clinic Appointment Scheduling

Zhecheng Zhu, Bee Hoon Heng, Kiok Liang Teow

Health Services & Outcomes Research, National Healthcare Group, Singapore
Zhecheng_zhu@nhg.com.sg

Outpatient clinic is an important component of healthcare system. The outpatient clinic studied in this paper mainly caters patients who make appointments in advance. Patients are referred by various sources in terms of appointment requests, and the clinic staff arranges an appointment for each appointment request by picking up an availabe slot through the appointment management system. In recent years outpatient clinic is facing increasing pressure to handle more appointment requests than before due to aging and growing population. One direct impact of the increasing pressure is the extended patient waiting time and clinic overtime. Better appointment schedules are needed to mitigate such pressure.

This paper applies genetic algorithm to generate new appointment schedules which guarantee better performance than schedules generated by other rules in terms of patient waiting time and clinic overtime under different clinic settings. The proposed genetic algorithm starts from an initial generation of schedules, which is composed of randomly generated schedules or schedules generated by other appointment rules. Genetic operators such as selection, crossover and mutation are designed to generate new schedules. Performance of the genetic algorithm is measured by the sum of patient waiting time and clinic overtime. Different clinic settings including number of planned appointments, no-show rates, lateness rates and consultation durations are considered in this paper. Computational results show that the proposed algorithm guarantees better schedules than other appointment rules under different clinic settings.

Keywords: Outpatient clinic appointment scheduling, Genetic algorithm, Health providers.

Epidemiology & Disease modelling (2)

M2_B

Modelling for seasonal influenza: combining agent-based simulation and social network models

Sally Brailsford[1], Christine Currie[2], Paul Davie[1]

[1] *School of Management, University of Southampton, UK*
{s.c.brailsford, p.a.davie}@soton.ac.uk

[2] *School of Mathematics, University of Southampton, UK*
c.s.m.currie@soton.ac.uk

This paper describes an agent-based simulation model for outbreaks of seasonal influenza, or "Freshers Flu", in a university. This illness, which is thankfully not normally serious, typically strikes at the start of a new academic year, when large numbers of young people arrive from all over the world and mix closely together in student residences, lectures and social events. The model uses a traditional Susceptible – Infected – Recovered (SIR) epidemiological model combined with a social network model located within a specific simulated physical environment. The population in this case is the new first-year student cohort at the University of Southampton. The model simulates an outbreak of 'flu within the university campus within the month of October, the first month of the new academic year. The population is modelled at the individual level using an agent-based approach. Agents (students) are given characteristics such as age, gender, hall of residence, degree programme, "sociability" and a friendship network. Their degree programme determines their daily lecture timetable and their "sociability" determines their evening activity (essentially, staying in alone to study or going out socialising with friends). The friendship network is derived from public-domain "Facebook" data. The model uses these characteristics to define a daily schedule for each student, which then determines their location at each point in the day. The model is then "seeded" with an infective and the progress of the epidemic, if one occurs, is tracked over time. The model can be used to advise the university management on the effectiveness of different control strategies: for example, whether or not to cancel lectures, or to quarantine certain groups of students, in the event of a serious outbreak.

Keywords: Seasonal influenza control, Agent-based simulation, Social network models, Patients.

M2_B

Optimal Control Applied to a Discrete Influenza Model

Paula A. Gonzalez-Parra[1], Leticia Velazquez [2], Maria C. Villalobos[3], Gerardo Chowell[4], Carlos Castillo-Chavez[4]

[1] *Program in Computational Science, The University of Texas at El Paso*, USA
pagonzalezparra@miners.utep.edu

[2] *Deparment of Mathematical Sciences , The University of Texas at El Paso, USA*
leti@utep.edu

[3] *Deparment of Mathematics, The University of Texas-Pan American, USA*
mcvilla@panam.edu

[4] *School Of Human Evolution and Social Change School of Mathematical and Statistical Science, Arizona State University, USA*
{gchowell, ccchavez}@asu.edu

A discrete time SIR model is proposed for analyzing the influenza dynamics for a given population over a time interval. The total population is divided into susceptible, infected, and recovered individuals. In addition the model is expanded in order to evaluate the potential effect of control measures such as treatment and social distancing. Assuming limited resources the implementation of control measures must be carefully determined. By using 1918 influenza pandemic data, we implement interior-point methods for estimating the fraction of the infected individuals to receive treatment and the social distancing to be applied in order to minimize the number of infected individuals.

Keywords: Disease policy modelling, Non linear programming, Patients, Simulation.

M2_B

Modelling intervention strategies for mosquito-borne diseases: The case of human travel between geographical regions

Mariagrazia Mecoli[1], Vanda De Angelis[1], Sally C. Brailsford[2]

[1] *Dipartimento di Statistica, Probabilità e Statistiche Applicate, Università "La Sapienza", Italy*
{mariagrazia.mecoli, vanda.deangelis}@uniroma1.it

[2] *School of Management, University of Southampton, UK*
S.C.Brailsford@soton.ac.uk

The present paper aims at evaluating the effect of different control strategies on the spread of an Ae. albopictus – borne disease – the chikungunya – due to human commuters travelling between two geographic regions, in one of which the disease has suddenly been imported. The disease can spread across different regions only due to human travel as the flight range of mosquitos is very limited and their dislocation through transport vehicles can be neglected. Obviously, only an infected person residing in a region and travelling to another one can export the disease, if he/she is bitten by a mosquito in the region of destination, that, as a consequence, becomes exposed and then infected, or an healthy traveller bitten by an infected mosquito in the region of destination can import the disease in his/her own region, by being bitten by a mosquito after returning in his/her region of residence. On the other side, a mosquito of a region can become exposed and then infected only if bitten by an infected human present in the region, either resident or visitor.

The spread of the disease is analysed by means of a System Dynamics model that describes the mosquito life-cycle, the evolution of the disease in humans/mosquitos, the travel process and the human behaviour. Control policies can contrast the diffusion of the disease by affecting the survival of either larvae or adult mosquitos, or by influencing the human behaviour in order to reduce the mosquito habitat or to prevent infectious humans from being bitten, by isolating them. The model is used to study and compare the effect of different control strategies.

Keywords: Mosquito borne diseases, System dynamics, Policy makers.

M2_B

Can we mitigate the effects of an influenza pandemic by vaccinating against pneumonia?

Christina Pagel[1], Sonya Crowe[1], Guy Walker[2], James Haybyrne[2], Peter Grove[2], Martin Utley[1]

[1] *Clinical Operational Research Unit, University College London, London, UK*
c.pagel@ucl.ac.uk

[2] *Health Protection Analytical Team, UK Department of Health, London, UK*

Many deaths from influenza are due to complications as opposed to the influenza virus itself. One of the most common complications is pneumonia, which can be due to a variety of causes including the pneumococcus bacterium. Bacterial pneumonia can be treated effectively with antibiotics, but might require hospitalisation or lead to death. A vaccine that provides some protection against pneumococcus is currently offered in the UK to people over the age of 65 and those with weakened immune systems. In the context of a pandemic, one strategy that might avert both deaths and hospitalisations would be to broaden the groups targeted by this vaccination programme. We have built a mathematical model to estimate the potential impact of such a strategy.

Keywords: Medical disaster management, Disease policy modelling, Mathematical modelling, System.

OR planning and scheduling (1)

M3_A

Operating Rooms Scheduling under Uncertainty

Isabelle Beaulieu[1,3], Michel Gendreau[2,3], Patrick Soriano[1,3]

[1] *HEC Montréal, Department of Management Sciences, Canada*
{valerie.3.belanger, patrick.soriano}@hec.ca

[2] *École Polytechnique, Applied Mathematics and Industrial Engineering Department, Canada*
michel.gendreau@cirrelt.ca

[3] *Interuniversity Research Center on Enterprise Networks, Logistics and Transportation (CIRRELT), Canada*

Operating rooms are considered as one of the most resources consuming services in modern day hospitals. Operating room managers must face conflicting constraints in order to build schedules which will both maximize resource utilization while minimizing cancellations and overtime. In particular, the variability of surgeries makes managing OR schedules efficiently a difficult challenge. In this study, we propose a four

step approach to build detailed OR schedules over a given planning horizon while taking indirectly into account surgery time variability. First, surgeries are assigned to a given day over the planning horizon (i.e. solving a case assignment problem). The assigned surgeries are then precisely scheduled during the selected OR session (time of day) according to different strategies and taking into account the different constraints on the availability of special equipments. The resulting detailed OR schedules are then evaluated through a simulation tool, allowing for comparisons between the performance of the different scheduling strategies with respect to the stochasticity of surgery times as well as providing a practical tool for feedback analysis and rescheduling if needed. Uncertainty is taken into consideration implicitly in two ways: first, through the a priori loading level of the schedule built during the case assignment problem and second, in the simulation step when the stochastic variables corresponding to the observed surgery times are realized. Each scheduling strategy is evaluated according to different performance criteria. Computational experiments performed on sixteen sets of randomly generated data (based on real data provided by a large Montreal hospital) are presented and analyzed in order to compare the different scheduling strategies considered.

Keywords: Surgery planning, Case assignment problem, Scheduling criteria, Detailed surgery schedules, Operating rooms, Stochastic surgery times, Integer programming, Simulation.

M3_A

Scheduling operating rooms under uncertainty: a stochastic programming approach

Domenico Conforti, Maria Elena Bruni, Patrizia Beraldi

Dipartimento di Elettronica, Informatica, Sistemistica,Università della Calabria,Italy
mimmo.conforti@unical.it,{mebruni, beraldi}@deis.unical.it

Operating theatre planning aims at optimally scheduling the surgical operations that will be performed in a considered planning horizon (one or two weeks), together with the date of the intervention and the operating room (OR) in which the surgical case will be performed.
The scheduling should take into account human, material constraints and surgical resources constraints as well as the inherent stochasticity characterizing the operating theatre environment (i.e . random surgical durations and random emergency patient arrival process).
This clearly implies possible disruptions on the elective surgeries scheduled on that day that may cause confusion in the daily work. Therefore, it is of paramount importance to take uncertainty into account in the planning phase. The aim of this paper is to develop stochastic mixed integer programming models to solve the advance scheduling problem in the presence of uncertainty.
In particular, a novel stochastic two-stage mathematical model is proposed for the scheduling both elective and emergency cases under the hypothesis that ORs are identically equipped and no special OR exists for the emergency cases, both elective and emergency operations have stochastic duration, and each surgical case can be assigned to any OR. In the proposed model decisions concerning the set of elective cases to be performed in each period over the planning horizon are taken ‘‘here and now” to hedge against all the future circumstances that may occur, whereas corrective actions that might postpone some scheduled surgery to a later date are taken in the second stage.
The model objective aims not only at maximizing utilization of operating rooms, but also at minimizing both over-utilization and under-utilization of ORs, as well as the penalty of delaying surgery to a later date.

Keywords: Logistics of health services, Operating room management, Stochastic programming, System, Health care providers, Patients.

M3_A

A two-level resolution approach for the stochastic OR planning problem

Elena Tànfani[1], Angela Testi[1], Rene Alvarez[2]

[1] *Department of Economics and Quantitative Methods, University of Genova, Italy*
{etanfani, testi}@economia.unige.it

[2] *Centre for Research in Healthcare Engineering, Department of Mechanical and Industrial Engineering, University of Toronto, Canada*
renealvarezc@gmail.com

A framework to deal with the Operating Rooms (ORs) planning problem considering stochastic surgery durations is herein presented. We assume a block-scheduling system and use as operative scenario an hospital department made up of different surgical sub-specialties sharing a given number of ORs.
A deterministic solution for the problem is firstly obtained by means of MIP models. The solution gives for each day of the planning horizon the assignment between surgical sub-specialty and OR, together with the subset of patients to be operated on. Demand constraints for each surgical unit, capacity constraints limiting the availability of operating time on each block and different operational constraints related to surgeons preferences, patient availability depending on surgery date, number of surgical teams available on each day, etc., have been considered.
A second level stochastic problem introduces the variability pertaining surgery durations by means of individual chance constraints for each OR block that must be verified within a given safety level. If lognormal distributions for surgery duration can be assumed, safety slack times are analytically calculated for each OR and day combination to be added to the deterministic first level problem formulation to get a robust solution. Otherwise, a Montecarlo simulation algorithm has been developed to verify the impact of including uncertainty pertaining operating times that follow any kind of distributions.

Keywords: OR planning, 0-1 LP model, Chance constrains programming, Montecarlo simulation, Patients, Surgery departments.

Logistics (1)

M3_B

Costs and benefits of innovation in healthcare logistics: evidences from two case studies

Giuliana Bensa, Stefano Villa, Isabella Giusepi

CERGAS (Centre for Research on Health and Social Care Management), Bocconi University, Italy
giuliana.bensa, stefano.villa, isabella.giusepi}@unibocconi.it

Background. In many Italian hospitals logistics is not considered as a potential driver for reducing waste, cutting costs and improving patient safety. In the last years, some hospitals recognized the benefits of a better logistic model and they started introducing new logistic solutions, especially in the drugs' management process.
Objectives: The overall goal of the study is to assess the costs and benefits of innovation in healthcare logistics. We analyzed two different hospital sites with different logistical models. One hospital is characterized by the introduction of advanced technologies such as Computerized Physician Order Entry, bar

coding for patient identification and the unit dose system for drugs distribution. The other one is, on the contrary, characterized by a traditional logistic system. The performance analysis has been carried out along four dimensions: quality, costs, financial savings and patient safety.
Methodology. The analysis of the cases is based on quantitative and qualitative data. We conducted semi structured interviews to the hospitals personnel involved in drugs distribution system and, on the basis of those results, we mapped, with the tool of flow charts, the organizational model. In addition to evaluate the patient safety, a questionnaire, based on Failure Mode Effect Analysis (FMEA), was administered to the personnel involved in the drugs logistics process.
Findings: the unit dose system shows relevant advantages in terms of costs and patient safety: the time spent by nurses in the drugs' management and drugs preparation is reduced and the patient safety is improved. The FMEA methodology shows that in the hospital that adopts the unit dose system employees (physicians and nurses) are more aware of the possibility of making errors.
Results. The introduction of logistics technologies implies organizational and cultural changes and a strong investment at the beginning, but the benefits in terms of efficiency and improvement of patient safety are relevant.

Keywords: Healthcare logistics, Drugs management, Case studies, Benchmarking, Hospitals.

M3_B

Simulation of multiple views of medicine distribution in a navy hospital pharmacy

Mário Jorge Ferreira de Oliveira[1], Rodrigo Abrunhosa Collazo[2], Leonardo Antonio Monteiro Pessôa[2], Leonardo Claro Garcia[2]

[1] *Federal University of Rio de Janeiro, Rio de Janeiro (Brazil) Programa de Engenharia de Produção – COPPE/UFRJ*
mario_jo@pep.ufrj.br

[2] *Centro de Análise de Sistemas Navais (CASVAV) - Marinha do Brasil*
rodrigocollazo@uol.com.br, lampessoa@gmail.com, leoclaro@terra.com.br

The field of simulation has developed in such a way that it is now possible to build a model that comes close to reality. Recent progress points to the direction of considering simultaneously the viewpoints of the different entities involved in the real problem. The objective of this paper is to propose a novel method that integrates, at the same level of importance, the viewpoints of the most important entities involved in a particular hospital service. This method is applied to analyze and improve the medicine distribution system of a Brazilian Navy hospital pharmacy. It is argued that this method could contribute to improving the capacity of the discrete-event simulation representing and analyzing the real problem, focusing on its key points.

Keywords: Simulation, Multiple views, Pharmacy, Public hospital.

M3_B

An innovative procedure for the localization of health care devices and services

Laura Gaetano[1], Gabriella Balestra[2]

[1] *Dipartimento di Meccanica, Politecnico di Torino, Italy*
laura.gaetano@polito.it

[2] *Dipartimento di Elettronica, Politecnico di Torino, Italy*
gabriella.balestra@polito.it

The problem of choosing the correct localization for specialized health services or expensive complex medical devices, like for example Positron Emission Tomography (PET) or a radiation therapy division, is a difficult one because must take into account both technical logistic and political criteria. Different researchers provided solution to the problem of ambulance optimal location, others were concerned with the localization of healthcare services. The methods proposed were hierarchical systems, graph theory, stochastic approach, linear programming, heuristic techniques and so on. In this work we propose an original approach based on both meta-heuristics and multicriteria decision analysis (MCDA) to find an appropriate location.
First of all, the problem was formalized using the *p*-median problem formulation: locating *p* facilities (medians) in a predefined set with *n* candidate facilities to satisfy a set of demands, so that the total sum of distances between each demand point and its nearest facility is minimized. For solving it, we applied different meta-heuristic methods (such as Genetic Algorithm, Tabu Search (TS) and Ant System). The solution had exactly *p* elements, where *p* is the desired number of medians, and each element represents the index (an unique identity number) of a facility selected. The objective function implemented a MCDA method (Electre II), to take into account the different criteria.
A preliminary validation based on simulated data was performed to test the performances of the different meta-heuristics and to evaluate how critical is the definition of the Electre weights. To compare the goodness of the solutions found by the different methods we applied the same MCDA method used as objective function. The next step will be to test the system in real situations.
This approach will improve the procedures actually used because it gives clear evidence of the criteria that led to the adopted solution.

Keywords: Resource allocation in health care, Meta-heuristics, Multicriteria methods, System.

OR planning and scheduling (2)

T1_A

A tabu search approach for joint operating room assignment and scheduling

Roberto Aringhieri[1], Paolo Landa[2], Patrick Soriano[3], Elena Tànfani[2], Angela Testi[2]

[1] *Dipartimento di Informatica, Università degli Studi di Torino, Italy*
roberto.aringhieri@unito.it

[2] *Department of Economics and Quantitative Methods, University of Genova, Italy*
paolo.landa@yahoo.it, {etanfani, testi}@economia.unige.it

[3] *HEC Montréal, Department of Management Sciences, Canada*
patrick.soriano@hec.ca

In this paper we discuss the development of a tabu search algorithm to solve the joint operating room (OR) assignment and scheduling problem. Given a surgery department made up of different sub-specialties sharing a fixed number of operating rooms and beds, the problem is that of determining the allocation of operating time blocks to sub-specialties together with the subsets of patients to be operated on in each time block over a given planning horizon. The problem is firstly formulated as a 0-1 linear programming model with operative, capacity, and demand constraints as well as parameterized budget constraints. The problem under study is strongly NP hard, consequently we propose a tabu search approach to find good (suboptimal) solutions in reasonable computational times.
Preliminary computational results will be reported and compared with those provided by a 0-1 LP based heuristic.

Keywords: OR planning, 0-1 programming model, Tabu search, Patients, surgery departments.

T1_A

A Rollout Algorithmic Approach for Complex Parallel Machine Scheduling in Healthcare Operations

Michele Ciavotta[1], Gabriella Dellino[2], Carlo Meloni[3], Marco Pranzo[2]

[1] *Grupo de Sistemas de Optimizacion Aplicada, Instituto Tecnologico de Informatica, Universidad Politecnica de Valencia, Spain*
mciavotta@iti.upv.es

[2] *Dipartimento di Ingegneria dell'Informazione, Università di Siena, Italy*
{dellino, pranzo}@dii.unisi.it

[3] *Dipartimento di Elettrotecnica ed Elettronica, Politecnico di Bari, Italy*
meloni@deemail.poliba.it

Operations Management calls to tackle different scheduling problems. Often the environment to consider can be modeled with a set of parallel resources to be scheduled and is characterized by one or more application-specific constraints or objectives.
Rollout methodology is effortless to implement and able to easy incorporate human experience inside its research patterns to fulfill complex scheduling requirements as those of interest in healthcare applications. A drawback is represented by the high computation time often required to terminate the algorithm.
We analyze a deterministic parallel machine scheduling problem showing how a rollout framework can be extended and adapted to tackle several additional constraints arising in healthcare operations, such as in the scheduling of operating rooms. We also describe simple methodologies that can be used to address the uncertainties in the problem.
A preliminary campaign of computational experiments, shows the behavior of different algorithmic variants of this approach.

Keywords: Resource allocation in health care, Operating room/Examination planning, Metaheuristic, Health providers (Unit & Hospital).

T1_A

Operating Room Planning and Scheduling: a Multiobjective Model solved via Genetic Algorithm

Domenico Conforti, Francesca Guerriero, Rosita Guido

Dipartimento di Elettronica, Informatica, Sistemistica, Università della Calabria, Italy
mimmo.conforti@unical.it, {guerriero, rosita.guido}@deis.unical.it

In recent years, increasing interest of Operation Researchers community has been devoted to the domain of operating room planning and scheduling. Within this complex and broad context, since the conflicting nature of several goals, we have developed an optimization model formulation whose main aim it to assign surgeries of different surgical specialties to multiple operating rooms in a block system based strategy. The model determines the assignment of time slots to the surgical teams and schedules the elective inpatient surgical operations on the basis of clinical priorities. The model is based on a multi-objective approach and solved by a suitable implementation of genetic algorithm. The proposed multi-objective approach takes into account and suitable balances some strategic and conflicting goals, related to the improvement of resources utilization and considering patient's priority value. The set of efficient solutions have been obtained on several scenarios, based on both real-life data and random data.
Preliminary results demonstrate the effectiveness of the proposed approach and confirm the strategic impact of optimization quantitative approaches as effective and efficient tools for complex decision making problems in the organization and management of health care delivery.

Keywords: Operating room management, Multiobjective programming, Metaheuristics, Health providers, Patients.

T1_A

Surgical Services Efficiency and Hospital Capacity

Seyyed Mohammad-Taghi Fatemi-Ghomi[1], Saeedeh Ketabi[2], Mehdi Mahnam[3]

[1] *Department of Industrial Engineering, Amirkabir University of Technology, 424 Hafez, Tehran, Iran*
fatemi@aut.ac.ir

[2] *Department of Management, University of Isfahan, Iran*
sketabi@yahoo.com

[3] *Department of Industrial Engineering, Amirkabir University of Technology, 424 Hafez, Tehran, Iran*
mmahnam@aut.ac.ir

Planning surgical activities is not an easy task due to the large number of decisions that should be considered. In general, different surgical services demand operating rooms (OR) to treat elective patients, each competing for a limited supply of OR time. The first phase in OR planning is to determine the number of OR time allocated to each surgical service. Data envelopment analysis (DEA) is a multicriteria decision making technique that hospitals and surgical groups can use to understand their potential to grow different specialties of inpatient surgery. Previous papers have described how DEA can be employed to calculate the technical efficiency of similar departments in different hospitals. The current research studies the efficiency of different surgical services within Azzahra Hospital, a teaching large-specialty hospital in Isfahan, Iran, where here are 20 ORs for elective surgeries of 10 groups, approximately 65-75 surgeries per day.

The variable returns to scale model of DEA is used to evaluate the efficiency of each surgical group. Some of factors that reveales the service performance are : no. of surgeons in the group, average (marginal) revenue, educational criteria such as no. of residents, and percentage usage of the allocated OR time (filling, cancellation, and delay). Some qualitative factors have been integrated as type of surgeries in the group that consists of : demand or waiting list, average of required (pre, peri, post operative) resources, average surgery time, and degree of complexity considering infection possibility and medical mistakes. This is quantified by voting and priorities which are collected from OR supervisor. The efficiency score determined by DEA model based on the historical data, can be used to the allocation of additional OR times.

Keywords: Operating Room, Efficiency, Data Envelopment Analysis

Planning health services (1)

T1_B

Analysis, Modeling and Improvement of Patient Discharge Process in a Regional Hospital

Nancy Khurma, Zbigniew J. Pasek

Industrial and Manufacturing Systems Engineering Dept., University of Windsor, Canada
{khurma, zjpasek}@uwindsor.ca

This paper presents results of a study conducted jointly with a regional hospital and concerned with inpatient discharge process. Initially, since no unified discharge procedure was in place, through staff interviews and direct observation a process map was developed. In addition to a thorough mapping of the existing process flow, an analysis of 1700 historical patient cases were conducted. Results revealed that in its current form the process is inadequately defined, lacks consistency due to varying interpretations of necessary steps by personnel involved, and its performance is hard to predict. Combined, all of these issues contribute to significant inpatient overstays past their prescribed acute care periods (so called Alternative Level of Care, or ALC days) and as a result at least 8 percent of available hospital bed capacity is wasted. Key factors extending unnecessary patient stays were identified and used as predictors to model length of stay (LoS) of individual patients. Another simulation model was created to explore the effects of standardizing parts of the discharge process. Obtained results indicate that organizational changes (e.g., early involvement of social workers, improved information flow, close collaboration with external facilities accepting patients, etc.) will lead to process improvement and substantial economic benefits.

Keywords: Performance measurement/evaluation in discharge planning for health care facilities, Patient flow management, Statistical analysis and simulation, Health providers (hospital).

T1_B

Assessing the performance of capacity planning through simulation analysis

Guoxuan Ma, Erik Demeulemeester

FBE, Catholic University of Louvain, Belgium
{Guoxuan.Ma, Erik.Demeulemeester}@econ.kuleuven.be

At the tactical level, the optimal case mix decisions with their corresponding capacity allocation schemes are solved through maximizing the overall contribution to a hospital system. However, different optimal case mix patterns associated with various capacity allocation scenarios will produce dissimilar effects on the delivery of health services when variability comes into play. Therefore, it is meaningful to develop simulation models to evaluate the performance of capacity planning in the health care sector. In this paper, the simulation analysis will consist of two parts. Firstly, the impacts of different optimal case mix decisions on capacity utilizations, especially on bed occupancies, will be compared. The performance indicators comprise the volume of misplaced patients due to the bed shortage in the most suitable ward and the patient misplacement bed-days of each ward. Moreover, in order to balance the bed occupancy levels maximally, a few strategies are proposed, such as averaging the spare beds, overrunning the operating rooms (OR) and adopting the flexible OR blocks, etc. Secondly, the sensitivity analysis will be carried out to check whether the number of patient misplacements can be reduced and how the bed shortage phenomenon can be mitigated. Three approaches are suggested and executed in the simulation experiments, that is, overplanning the capacity (equally reducing the patient arrival rate), appropriate bed expansion and curtailing the distribution of the length of stay respectively.

Keywords: Capacity allocation, Case mix decision, Bed occupancies, Discrete-event simulation, Sensitivity analysis.

T1_B

Capacity Planning and Scheduling for Long Term Care

Jonathan Patrick

Telfer School of Management, University of Ottawa, Canada
patrick@telfer.uottawa.ca

Inadequate access to long term care represents a major challenge as our population continues to age. It is the cause of much of the congestion in the hospitals as backlogs of patients waiting for long term care block more and more hospital beds. It is also the cause of stress and anxiety in the community as clients deemed to require long term care are nonetheless forced to wait months and even years for placement. The scheduling of clients to long term care is a complex problem that is compounded by the non-homogeneity of long term care beds (different facilities and room accommodations), the presence of client choice and the competing demands of the hospital and community populations. We present a Markov decision (MDP) model that determines the required access in order for the census of patients waiting for long term care not to exceed a given threshold. We further present a more complex approximate dynamic programming (ADP) model that seeks to address the combined scheduling of hospital and community clients. Finally, we present a simulation model that incorporates both hospital and community demand for long term care in order to predict the impact of running the policies derived from the MDP and ADP models on the wait times for community clients and to aid in capacity planning for the future. We test the MDP policy versus current practice as well as against a number of other proposed policy changes.

Keywords: Resource allocation in health care, Approximate dynamic programming, MDP, Regional.

T1_B

Hospital Expansion Planning- Achieving Treatment Growth Targets

Peter Vanberkel

Department of Applied Mathematics, Department of Operational Methods for Production and Logistics University of Twente, The Netherlands
p.t.vanberkel@utwente.nl

Dutch hospitals are becoming more focused in the types of treatments they want to provide to patients. To achieve their desired targets for each treatment, hospitals can choose to attract only certain patient types (characterized by their symptoms) to the hospital. The actual treatment required by a patient is subject to randomness. Furthermore, patient arrival rates evolve over time. In this presentation we describe a mathematical model to determine the policy for accepting new patient types that best matches the desired treatment growth targets. We model the hospital as an M/G/∞ queuing system and select patient types in a manner similar to that used in the Project Sequencing Problem

Keywords: Expansion planning, Patient mix decisions, DRG mix decisions, Queuing theory, Project sequencing problem.

EMS (1)

T2_A

Models for the optimal composition of medical crews in emergency services

Bernardetta Addis [1], Roberto Aringhieri [2], Giuliana Carello[1], Andrea Grosso[2], Francesco Maffioli[1]

[1] *Diaprtimento di Elettronica ed Informazione, Politecnico di Milano, Italy*
{addis, carello, maffioli}@elet.polimi.it

[2] *Dipartimento di Informatica, Università degli Studi di Torino, Italy*
{roberto.aringhieri, grosso}@di.unito.it

In an emergency medical service a quick response to patient calls is a key issue to guarantee the highest probability of rescue in case of severe injury or heart attack. In EMS, an operations center is in charge of receiving the calls, providing the first triage, summoning ambulances and sending them to patients. Therefore, the level of performance of the operational center has a deep impact on the service provided to citizens. When the operations center is part of a hospital, such as in Milano, it is considered as a ward: in this case the same shifts of other wards of the hospital are applied to the personnel of the operations center. However, nurse rostering in classical wards, which has been widely studied, does not meet the requirements of an operational center. In fact, personnel rostering is usually planned in order to meet covering requirements, namely to provide the required number of nurses in every interval of the day. Instead, the operations center personnel rostering must provide a fair level of performance during all the day. Besides, the demand to be met by an operational center may vary during the daytime, being usually higher during working hours of the day. Thus, hospital shifts turn out to be not suitable to deal with emergency demands.
We studied the problem of assigning operational center personnel to teams and teams to shifts with the goal of providing a suitable level of performance and efficiency of the operational center, taking into account the different number of calls during the daytime. Different features of the problem are considered, such as teams composition, different personnel skills and level of efficiency, cooperation between different teams. We

developed mathematical models of the problems, and heuristic solutions and relaxation based on column generation. The developed approaches are applied to a real life case provided by Milano emergency service operational center.

Keywords: Crew assignment, Personnel rostering, Mathematical models, Optimization, System, Emergency service management.

T2_A

Single and multi-group evacuation in medium and maxi health-care emergencies

Edoardo Amaldi, Stefano Coniglio, Claudio Iuliano

DEI, Politecnico di Milano, Italy
{amaldi, coniglio, iuliano}@elet.polimi.it

We consider the problem of evacuating injured people in the context of a *medium or maxi health-care emergency* such as, e.g., an air plane crash, a maxi-intoxication, or a major car accident. Given a set of patients, with, for each of them, a color code indicating the gravity and the set of medical specialties that they need, and a set of hospitals, with their distance from the emergency site, their resources (in terms of number of people that can be received) and competences in performing specific treatments, the problem amounts to decide to which hospital each patient must be sent and the ambulance to be used.
Two variants are considered, based on whether the patients are to be evacuated simultaneously (single group scenario) or in a sequence of groups (multi group scenario), such as, e.g., in the case of a collapsed building, where they are extracted from the rubble in small groups. We propose an integer linear programming formulation for the problem and show that, by relaxing the integrality constraints on some variables, the formulation still yields integer solutions. The strategy to tackle the multi-group case is based on solving, iteratively, a variant of the single-group formulation, where we take into account both the patients that are to be evacuated at the current stage and an estimate of those which are still to be considered. This is coupled with the introduction of tight restrictions on the number of ambulances. The idea is to avoid early consumption of scarce resources as much as possible.
Computational results are reported for both variants of the problem.
The work is part of DECEMbRIA, a research project funded by the Italian Lombardy Region and carried out in collaboration with the emergency service (118) of Milan.

Keywords: Decision support systems for medium/maxi health-care emergencies, Integer linear programming, System.

T2_A

Triage and routing of emergency patient – optimal level for triage

Tomi Malmström[1], Paulus Torkki[1], Raija Malmström[2]

[1] *BIT Research Centre, Aalto University, Finland*
{tomi.malmstrom, paulus.torkki}@tkk.fi

[2] *Hospital District of Helsinki and Uusimaa, Finland*
raija.malmstrom@hus.fi

In emergency care patient's routing is a responsibility of a triage nurse. In an evaluation of patient's triage, the nurse has to decide on various aspects in just few minutes. The nurse has to make a decision on the urgency and needed resources basing on the evaluation of the patient's symptoms and their severity, other diseases and overall status. The triage nurse must be able to apply principles and concepts to differing situations. Decisions made by triage nurse are vital in determining the course of emergency care. Under-triage prolongs unnecessarily the treatment and weakens patient's perceived service quality. However over-triage burdens highly specialised resources of healthcare system and thus some degree of under-triage exists to avoid high expenses and overloading of specialists. The objective of this study is to analyse triage-making process and decide on an optimal level for triage. Statistical analysis is conducted on triage and routing data of hospital's emergency department. The material includes all patient cases of one year's time frame in the emergency department. The results indicate that specific types of symptoms are involved in the majority of under-triages. Especially difficulties in breathing, stomach pains, and symptoms of different bone fractures are symptoms that are under-triaged more often than other symptoms. We suggest that optimal level for triage should be determined specifically for different symptom categories.

Keywords: Resource allocation in health care, Logistics of health services, Statistical analysis, Health providers.

T2_A

Design of Logistics Networks for Disaster Relief

Monia Rekik, Jacques Renaud, Angel Ruiz

Université Laval, Operations and Decision Systems Departement, Canada
Interuniversity Research Center on Enterprise Networks, Logistics and Transportation (CIRRELT), Canada
{monia.rekik, jacques.renaud, angel.ruiz}@fsa.ulaval.ca

This talk addresses the strategic problem of designing a network of humanitarian aid. The goal is to determine the number of humanitarian help facilities to open, their location, the humanitarian functions offered by each facility that may correspond to the distribution of tangible products (food, water, medical supplies, beds, blankets, shelters,...) or services (securing a bridge, restoration of a power line) and the allocation of resources (e.g. personnel and the number of vehicles) to each center according to their mission and responsibilities.

The problem of designing humanitarian aid networks is presented here as a sequence of decisions that mimics the decision process observed in real-life emergency situations. In other words, instead of working around a monolithic approach, we propose to adopt a distributed one based on a decomposition of the problem according to the hierarchy of decisions. Such a decomposition allows us to represent the problem through several interconnected sub-problems rather than making a single model. The decomposition approach offers several advantages. First, sub-problems are smaller in size than a monolithic model and therefore easier to handle and solve. In addition, by "splitting" the overall problem into several sub-problems, a high degree of flexibility is allowed to managers to select the desired level of detail at each step, or to question some decisions at any level.

Keywords: Logistics of humanitarian aid, Network design, Integer programming, System.

Planning health services (2)

T2_B

Idealised Design and Modelling of Alternatives to Hospital Care

Tom Bowen

The Balance of Care Group, UK
tom.bowen@balanceofcare.com

In many projects for local health economies we have identified alternatives to acute hospital admission and care. Commonly this requires the introduction of a range of new services and corresponding changes to clinical practice and care pathways. An integrated holistic approach is essential and it can be demonstrated that small changes across a range of agendas is likely to have a greater impact than any single large scale initiative.
We have modelled potential capacity and clinical process changes across sixteen local health economies in different parts of the UK, and all regions of the Republic of Ireland, informed by special bed utilisation surveys. Projects often focus on the requirements for rehabilitation and integrated care, including support for people with multiple long term conditions and frailty.
These projects are a further development of the Balance of Care modelling approach; incorporating transparent presentation of data, multidisciplinary involvement, and idealised design. In this we are following Ackoff's paradigm of "designing a desirable future and inventing ways of bringing it about".
As the evidence base increases so too does the potential for introducing dynamic modelling elements. This carries the potential danger of arriving at 'technical solutions' to issues, and it is important that the participative role remains central.

Keywords: Care pathways, Whole systems, Idealised design, Clinicians, Managers.

T2_B

Discrete conditional phase-type models utilising classification trees: application to modelling maternity services

Paul Harper

Cardiff School of Mathematics, Cardiff University, UK
harper@cardiff.ac.uk

This paper introduces a Discrete Conditional Phase-type (DC-Ph) Markov process for modelling health service capacities by better predicting service times, as captured by Coxian Phase-type distributions, interfaced with results from a classification tree algorithm. DC-Ph models consist of a process component (survival distribution) preceded by a set of related conditional discrete variables, here captured by the classification tree.
To illustrate the approach, a case-study in maternity services is given. Pregnancy, although being one of the most natural processes in our evolution, still remains subject to numerous complications and potential high risk. Complications at birth, such as the need for a caesarean section or the use of forceps, are not uncommon. Working with a UK hospital, a DC-Ph model has been constructed using classification trees based on predicting the probability of a 'non-spontaneous (complicated) delivery', defined by clinicians as a delivery other than that of a natural birth; for example, an emergency caesarean section, breech presentation, the use of forceps or a shoulder dystocia. Data on 6,012 non-elective births are used in the study to find risk

groupings ranging from 7% to 68% of a complicated birth. Based on the classification tree predictions, the duration of childbirth on the labour ward is then modelled as either a two or three-phase Coxian distribution. The DC-Ph model is then used to calculate the numbers of patients (mothers in childbirth) on the labour ward and associated bed occupancy and needs. The consequences on resource needs by changing risk status are then modelled by modifying the parameters of the classification tree. Finally, equations are derived to calculate patient turnover and compare results using deterministic average length of stay and the stochastic Coxian phase-type distribution.

Keywords: Planning health services, Patient flow management, Maternity services, Childbirth risks, Discrete conditional phase-type models (DC-Ph), Classification trees, Coxian phase-type distributions,: Health providers, Patients.

T2_B

Establishing weighting criteria for prioritising health care services for professionals, patients and the public

Penelope Mullen

University of Birmingham, UK
penelope.mullen@btinternet.com

English Primary Care Trusts (PCTs) are responsible for commissioning (financing and securing) healthcare services for their local population (mean c330,000, range c90,000-1,300,000 people). In doing this PCTs are required to demonstrate use of explicit prioritisation which is informed by patient and public engagement.
A project was commissioned by a medium-sized PCT to establish weighting criteria, based on the values of professionals, patients and the public, which could be used in planning and prioritisation of services. Potentially controversial proposals to 'reconfigure' local primary-care (PC) services led the PCT to select this area as the focus for the project. A set of criteria was drawn-up from a workshop, consultations and documentary analysis. Self-completion questionnaires, designed to elicit respondents' views of the relative importance of these criteria using two different value-elicitation techniques – one unconstrained and one constrained – were administered by a variety of methods to members of the public, general practitioners (PC doctors), PC nurses and senior PCT HQ officers and board members. Whilst many similarities were found, the responses reveal a number of interesting differences between the public and healthcare professionals, and between different groups of healthcare professionals. A workshop is planned, involving volunteer members of the public, at which the findings will be presented and reviewed and the appropriateness of the methodology explored.
In addition to outlining the methodology and overviewing the findings from the survey and workshop, this paper will analyse the appropriateness of the value-elicitation techniques and methods of administration, both to the application area and to contexts where there is a large number of criteria and such different 'constituencies' are involved. Various lessons relating to choice of technique, the role of researchers in applied policy areas, problems of translating theory into practice, and to healthcare priority-setting in general, will be explored.

Keywords: Planning and prioritising health services, Value-elicitation, System, Public.

T2_B

Predicting future capacity needs for healthcare services at strategic and tactical levels

Honora Smith

School of Mathematics, University of Southampton, UK
honora.smith@soton.ac.uk

Predicting future capacity needs is of vital importance for any healthcare facility, in the long-term to ensure a sustainable service, and in the short-term for planning use of resources such as manpower. In the current financial position of the United Kingdom (UK) National Health Service, it is now critical to ensure that all new and re-structured services offered are well planned for capacity needs. This paper highlights modelling methods used in both these levels of planning for strategic and tactical purposes.
For a new facility where different possible geographical sites are possible, locational analysis provides routes for findings optimal locations, with accompanying capacity estimates. A case study is described of siting a new community centre (or "polyclinic") in the metropolitan area of Leeds, UK.
Where existing healthcare facilities are to be moved to a new location, changes of usage may occur because of the distance travelled, where there are alternative places to receive treatment. A case study in Derbyshire is described where hospital services are in the process of being moved to a new location. Several methods of predicting future usage are described, according to different assumptions of choosing place of access to treatment. Discrete choice modelling is used to predict future usage, with several variables assumed to affect patients' choice of hospital. Results are predicted for both elective (pre-planned) and non-elective (emergency) choice of hospital.
Finally, a number of different projects are described for which simulation techniques have been used in planning day-to-day or weekly healthcare capacity needs. These include a hospital outpatients clinic, an emergency department, a call centre for out-of-hours adult social care needs and a maternity ward.

Keywords: Planning health services/care, Discrete choice modelling, Simulation, Locational Analysis, Health providers.

OR planning and scheduling (3)

W2_A

Prediction of the Time to Complete a Series of Surgical Cases to Avoid Operating Room Overutilization

Rene Alvarez[1], Richard Bowry[2], Michael Carter[1]

[1] *Centre for Research in Healthcare Engineering, Department of Mechanical and Industrial Engineering at the University of Toronto, Canada*
renealvarezc@gmail.com

[2] *St. Michael's Hospital, Toronto, ON, Canada; Faculty of Medicine, University of Toronto, Canada*

Purpose: Operating room (OR) efficiency could be improved by reducing overutilization. In this paper we suggest a methodology to accurately estimate the time to complete a series of surgical cases to avoid OR overutilization.

Methods: We studied 6,090 cases performed in the cardiovascular surgery service at St. Michael's Hospital. Lognormal distributions were fitted to surgical times and turnover times. The distribution of the duration of the schedule was estimated using the Fenton-Wilkinson approximation. During three months, operating room data was collected and analyzed.
Results: The mean difference between the real durations of the schedules and the average durations was 0.19 hours (11.64 minutes). The mean difference with the 2/3 percentile point was 0.59 hours (35.40 minutes). On the other hand, the overrun schedules were correctly predicted by the average in 86.49% of the cases and by the 2/3 percentile in 94.59%. However, the average duration made 12 false predictions and the 2/3 percentile made 26.
Conclusions: These results suggest that the sum of the average duration of surgeries and turnover times is indeed a good estimator of the duration of the series of surgical cases. As well, they suggest that neither the estimated average nor the 2/3 percentile point are useful to predict overrun when used isolated. The authors suggest the combined use of both, the estimated average duration of the schedule and the 2/3 percentile point, to validate the planned schedule and to reduce overtime. Due to the successful results, this methodology was approved to be used in the cardiovascular service of St. Michael's hospital.

Keywords: Operating Room scheduling, Lognormal times, Sum of stochastic surgery times, Statistical analysis, OR managers, OR schedulers.

W2_A

Towards an optimal mix in planning and scheduling of operating theatres

Fabio Fruggiero[1], Alfredo Lambiase[2], Alessandro Braione[2]

[1] *Department of Engineering and Environmental Physics (DIFA), University of Basilicata, Italy*
fabio.fruggiero@unibas.it

[2] *Department of Mechanical Engineering (DIMEC), University of Salerno, Italy*

The absolute necessity to offer a constant high level of medical services to patients, notwithstanding the precariousness of resources as well as economy, is pushing healthcare managers/administrators towards increasing interest in worthy of admiration tools successfully applied into the industrial frame. It is uncovering the usefulness to apply operations management and scheduling approaches to services. Starting from a discrete event simulation model of real emergency facilities, the present paper deals with allocation scheduling in operating theatres framed to day care patient's arrival rate and pathological circumstances. It studies the impact of forecast and resources rationalization and calls and optimal arrangement for bed assignment and operating room services. A weekly time bucket has been used in planning. A daily based server mix and patient rate, in Cork University Hospital – Ireland, with different types of patient and multiple servers, which are either specialist and/or cross trained, will be analyzed. The application of an approach for optimization was used to evaluate alternative configurations in order to anticipate favourable assessments and to prevent mislaid of time and resources and quality. Fitting system constraints, a queuing network in multi-agent approach has been formulated. Parameters such as staff assessment, rota, paths, personnel management as well as turnover, equipment and instrument configuration have been taken into consideration.
Moreover, decide on the right mix of flexible and dedicated equipments is part of designing the service in medical delivery system. Hence, strategic system and human resources flexibility in services are going to be investigated. The impact of replacing dedicated servers by flexible ones will be evaluated. The flexible capacity will be quantified and patients expectation in terms of waiting time will be shielded. The right level of flexibility of health care services, enabling decision makers to improve system performance in accordance with strategic objectives, will be evaluated. Taking into account the service delivery and medical staff availability and the patient downtime cost, the authors will show that total flexibility is not always the best choice. As final output, authors are proposing a viable tool, i.e., synoptic prospect, which can give managers and planners the opportunity to identify, measure and test, ex ante, the booked feasibility and system

availability in terms of flexibility in operating care services, hence enabling them to improve system performance in accordance with strategic objectives and forecast and overcrowding.

Keywords: Decision support systems for health care, Service system design, Operating room/Staff scheduling, Flexibility, Optimization, Simulation, Queuing network, Agent based approach, Health provider, Service level to patients, Sustainable health system.

W2_A

Improving operational effectiveness of tactical master plans Illustrated with cardiothoracic surgery

Jan Vissers[1], Ivo Adan[2] , Jos Bekkers[3], Nico Dellaert[4], Jully Jeunet[5]

[1] *Institute of Health Policy and Management, Erasmus University Rotterdam, The Netherlands*
vissers@bmg.eur.nl

[2] *Department of Mathematics and Computer Sciences, Eindhoven University of Technology, The Netherlands*
iadan@tue.nl

[3] *Department of Cardiothoracic Surgery, Erasmus University Medical Centre Rotterdam, The Netherlands*
j.a.bekkers@erasmusmc.nl

[4] *Department of Technology Management, Eindhoven University of Technology, The Netherlands*
n.p.dellaaert@tm.tue.nl

[5] *CNRS, Lamsade, Université Paris Dauphine, France*
jully.jeunet@dauphine.fr

This paper develops a two-stage planning procedure for master planning of elective and emergency patients while allocating at best the available hospital resources. Four types of resources are considered: operating theatre, beds in the medium and in the intensive care units, and nursing hours in the intensive care unit. A tactical plan is obtained by minimizing the deviations of the resources consumption to the target levels of resources utilization. Some capacity is reserved for emergency care. To deal with the deviation between actually arriving patients and the average number of patients on which the tactical plan is based, we consider the option of planning a higher number of patients (overplanning). To adapt the tactical plan to the actual stream of elective patients, we also consider flexibility rules. Overplanning and flexibility leads to an operational plan of elective patients. This plan is modified to account for emergency patients. Scheduled elective patients may be cancelled and emergency patients may be sent to other hospitals. Cancellations rules for both types of patients rely on the possibility to exceed the available capacities. Several performance indicators are defined to assess patient service and hospital efficiency. The performance of our procedure is evaluated through simulation experiments with low and high demand for emergency care. Simulation results show a trade-off between hospital efficiency and patient service. We also obtain a rank of the different strategies: overplanning, flexibility and cancellation rules.

Keywords: Operating theatre planning, Admission planning, Master surgical plan, Mixed integer planning, Simulation, Flexibility, Overplanning, Cancellation rules.

W2_A

Modelling trauma hip fracture patients: the impact on operating theatres and the orthopaedic ward

Cheryl Voake, Jeff Griffiths, Janet Williams

School of Mathematics, Cardiff University, Wales, UK
voakec@cardiff.ac.uk

Trauma hip fractures are becoming an increasing issue within hospitals due to the ageing population. Many patients do not undergo surgery promptly due to a variety of reasons and the impact of this on post-operative length of stay and mortality are discussed.
A simulation model was built in order to make further analyses of the effect of operative delay on this patient group possible, within a large teaching hospital. Inputs to the model were determined, along with detailed data mining, using a variety of statistical techniques; including categorical principal components analysis (CatPCA) and classification and regression trees (CART).
This issue can also be addressed from the aspect of the operating theatre. A substantial number of operations are postponed due to lack of theatre time; with a better understanding of how the theatre works and the time taken to complete various stages of the theatre process, this can be improved upon. By collapsing these time intervals into various Erlang distributions and using the process of Laplace transform inversion, the possibility of representing the overall time taken to complete the theatre process by a single distribution is explored.

Keywords: Patient Flow Management, Simulation, Queuing Theory, Health Providers.

Epidemiology & Disease modelling (3)

W2_B

Quantitative Decision Support for CardioVascular Medicine: WROVASC project

Marek Lubicz[1], Piotr Piszko[2], Bożena Mielczarek[1], Jacek Zabawa[1]

[1] *Department for Computer Science and Management,Wrocław University of Technology, Poland*
{marek.lubicz, bozena.mielczarek, jacek.zabawa}@pwr.wroc.pl

[2] *Regional Specialist Hospital in Wroclaw,Research and Development Center, Poland*

This paper reports initial results of a task group within a multicentre research project WROVASC, co-ordinated by the Regional Specialist Hospital (RSH) in Wrocław, Poland. The poject concerns particular clinical and biotechnology topics in the domain of cardio-vascular (CV) medicine. CV diseases are the major cause of morbidity and mortality worldwide, and also one of the main causes of hospitalization. Clinical CV literature points out multifaceted aspects of the problem domain, metabolic and societal background of many CV diseases, their relations with other body systems, availability of modern diagnostic and therapeutic methods, importance of optimizing clinical pathways. In health care literature the attention is paid to high costs and resource consumption, effectiveness and efficiency of diagnostic and treatment options, and the necessity of in-hospital but also region-wide resource allocation and their rational use.
Both in clinical and in managerial health care decision making at regional or hospital level, particular data bases, be they clinical, epidemiological or managerial, are in use, concerning diagnostic and treatment

processes of CV patients, use of resources, and output measures. The authors co-operate in a sub-module of the WROVASC project on developing an intelligent decision support system for CV medicine (CV-IDSS), particularly in modelling clinical intra-hospital paths and regional health-care system diagnostic and treatments pathways primarily for patients with pulmonary embolism, both with and without mention of acute cor pulmonale. This group of CV patients constitutes a small fraction of all CV hospitalized patients (6% of all CV patients in the RSH), while the group in-hospital mortality is 15%.
The general idea of the analytic and decision support module is based on an open-system model and linked data-bases paradigm, as well as regional perspective to external (economic, societal and epidemiologic) and internal (intra-CV medicine) processes. The modelling core of the CV-IDSS will be a discrete-event simulation model of the regional CV medicine system, while the structure for linked data-bases will be built up using an intelligent data warehouse engine. Current work concerns linking existing intra-regional data bases, built for various routine purposes (including those of public payer institution, public statistics, and local hospital CV admission/discharge systems). The use of the system will be driven by data mining procedures incorporated in Statistica Data Miner and particular Machine Learning algorithms. The ultimate aim of the task is to enable analysing clinical paths and epidemiological phenomena, and supply hospital and regional decision makers with rational decision support tools.

Keywords: Decision support systems, Simulation, Statistical analysis, Data mining, Cardiovascular medicine.

W2_B

Self-adaptive case based reasoning for dose planning in radiotherapy

Nishikant Mishra[1], Sanja Petrovic[1], Santhanam Sundar[2]

[1] *Automated Scheduling, Optimization and Planning Research Group*
School of Computer Science, University of Nottingham, Nottingham, UK.
{nxm ,sxp}@cs.nott.ac.uk

[2] *Department of Oncology, Nottingham University Hospital NHS Trust Nottingham, UK*
Santhanam.sundar@nuh.nhs.uk

Prostate cancer is the most common cancer in the male population. Radiotherapy is often prescribed in combination with other means of treatment to control the abnormal growth of cancer cells. In radiotherapy treatment the oncologist makes a trade-off between the risk and benefit of the radiation i.e. the task is to deliver the high dose to the cancer cells and minimize the side effects of the treatment. A case based reasoning is developed to capture the expertise and experience of oncologists in treating previous patients. The proposed novel trade-off function makes a trade-off among the similarity between previously treated patients and a new one, 5 years Progress Free Probability (probability of remain disease free after 5 years of treatment) of past cases and the success rate measured 2 years after the treatment. The system recommends dose in phase I and phase II of the treatment of a new patient. Importance (weights) of different clinical parameters in the dose planning are highly subjective and are generally fixed by the system with the input from the oncologist based on their past experience. In our system, after each use of the proposed approach weights corresponding to each feature used in the retrieval process are updated automatically using the developed cluster based Simulated Annealing approach. The developed approach is analyzed on the real data sets collected from the Nottingham University Hospitals NHS, City Hospital Campus, UK. Extensive experiments show that in most of the cases, the dose plan suggested by the proposed method is coherent with the dose plan prescribed by an experienced oncologist. The proposed approach can assist both new and experienced oncologists in the treatment planning.

Keywords: Prostate cancer, Radiotherapy, Case based reasoning, Simulated annealing, Clustering, Patients.

W2_B

Enabling health, independence and wellbeing for bipolar patients via Personalised Ambient Monitoring (PAM)

Syed Mohiuddin, Sally Brailsford

School of Management, University of Southampton, UK
{s.g.mohiuddin, s.c.brailsford}@soton.ac.uk

Bipolar disorder is a chronic mental disorder associated with two types of recurring episodes, mania and depression, which are marked by periods of remission and irregular sub-threshold symptoms. Early detection of transitions between the normal, manic and depressed stages is a crucial treatment issue. Via self-awareness and long-term monitoring, bipolar sufferers can manage their condition. Most proposed long-term self-management interventions to date have mainly been manual and diary-based. Such interventions are not only very time-consuming and expensive, but are also prone to reporting errors and missing data. Moreover, they are less effective in detecting the depressive aspects of the disorder. Automated ambient data collection may reduce such errors, enrich data quality and detect both aspects of the disorder. The aim is to reduce the number of acute mood events and hospitalisations, to empower patients through self-management, and achieve potential cost savings.
The PAM project has involved the development of an automated unobtrusive system to support the early detection of any imminent transitions. The PAM system collects a range of personal activity information from patients via a sensor network. This is used to develop an "activity signature" for that individual. Based on the clinical literature and consultations with our clinical collaborators, a disease state transition model was developed in Excel. This model was then used in a Monte Carlo simulation to test a range of monitoring scenarios, for example the removal or technical failure of a sensor or the limited availability of various types of data. The decision rules and algorithms in PAM routinely compare a patient's current behaviour with his/her "normal" behaviour to check if a threshold level has been exceeded, and if so, will issue an alert to the patient. Since a full-scale clinical trial was impracticable in this project, the simulation provides information which will enable us to evaluate the effectiveness of the PAM algorithms.

Keywords: Personalised monitoring, Markov modelling with Monte Carlo simulation, Bipolar patients.

W2_B

Enabling health, independence and wellbeing for bipolar patients via Personalised Ambient Monitoring (PAM)

Syed Mohiuddin, Sally Brailsford

School of Management, University of Southampton, UK
{s.g.mohiuddin, s.c.brailsford}@soton.ac.uk

Bipolar disorder is a chronic mental disorder associated with two types of recurring episodes, mania and depression, which are marked by periods of remission and irregular sub-threshold symptoms. Early detection of transitions between the normal, manic and depressed stages is a crucial treatment issue. Via self-awareness and long-term monitoring, bipolar sufferers can manage their condition. Most proposed long-term self-management interventions to date have mainly been manual and diary-based. Such interventions are not only very time-consuming and expensive, but are also prone to reporting errors and missing data. Moreover, they are less effective in detecting the depressive aspects of the disorder. Automated ambient data collection may reduce such errors, enrich data quality and detect both aspects of the disorder. The aim is to reduce the number of acute mood events and hospitalisations, to empower patients through self-management, and achieve potential cost savings.

The PAM project has involved the development of an automated unobtrusive system to support the early detection of any imminent transitions. The PAM system collects a range of personal activity information from patients via a sensor network. This is used to develop an "activity signature" for that individual. Based on the clinical literature and consultations with our clinical collaborators, a disease state transition model was developed in Excel. This model was then used in a Monte Carlo simulation to test a range of monitoring scenarios, for example the removal or technical failure of a sensor or the limited availability of various types of data. The decision rules and algorithms in PAM routinely compare a patient's current behaviour with his/her "normal" behaviour to check if a threshold level has been exceeded, and if so, will issue an alert to the patient. Since a full-scale clinical trial was impracticable in this project, the simulation provides information which will enable us to evaluate the effectiveness of the PAM algorithms.

Keywords: Personalised monitoring, Markov modelling with Monte Carlo simulation, Bipolar patients.

Patient flow (2)

TH1_A

The economic benefit of thrombolysis for post-stroke community care – A simulation model

Maria Barton[1], Sally McClean[1], Lailt Garg[1], Ken Fullerton[2]

[1] *School of Computing and Information Engineering, University of Ulster, Coleraine, UK*
m.barton@ulster.ac.uk

[2] *School of Medicine, Dentistry, and Biomedical Sciences, Queen's University, Belfast, UK*
ken.fullerton@belfasttrust.hscni.net

Previous research has suggested that thrombolysis, a clot busting drug, is an effective treatment for acute ischaemic stroke, significantly reducing dependency and mortality. Despite this, thrombolysis is currently only administered to 9.5% of suitable stroke patients in the UK. Administration of thrombolysis is initially expensive and requires access to specialised stroke services. There is concern that an increase in the proportion of those administered thrombolysis will be at the expense of post-discharge services, such as community rehabilitation. We present results of survival analysis performed to examine the relationship between length of stay (LOS) in hospital and discharge destination for those patients considered as suitable for thrombolysis. Kaplan Meier estimation and log rank test showed a significant relationship between LOS and destination to which discharged. Patients discharged to a Private Nursing home (PNH) have the lowest probability of early discharge.

We created two initial groups, patients that receive thrombolysis (T) and patients that do not receive thrombolysis (NT). On the basis of the survival analysis we then created six further subgroups of group T and group NT, to accommodate the different destinations to which patients were discharged, i.e. home, PNH and death. The groups were used to form the basis of a discrete event simulation model, where each group is a patient pathway with the simulation. Phase type models were fitted to each of the six subgroups starting with one phase (the exponential). In each case the Coxian phase type distribution was used to model LOS for the group. Costs were added to each subgroup, based on UK figures. Various scenarios were explored by adjusting the proportion of patients receiving thrombolysis. An increase in the proportion of patients that receive thrombolysis resulted in a decrease in the total cost of hospitalization and community care; in particular community rehabilitation and PNH care.

Keywords: Costing stroke services, Survival Analysis, Discrete Event Simulation, Health providers.

TH1_A

Modelling acute stroke thrombolysis pathways with Value-Focused Process Engineering

Auður Friðriksdóttir[1,2], Leonid Churilov[1,2], Helen M. Dewey[1,2,3]

[1] *National Stroke Research Institute, Melbourne, Australia*
lchurilov@nsri.org.au

[2] *The University of Melbourne, Australia*

[3] *Austin Health, Melbourne, Australia*

Stroke is the second most common cause of death and major cause of disability worldwide. About a quarter of stroke patients are dead within a month, about a third by 6 months, and a half by 1 year. Stroke-related disability is judged to be the sixth most common cause of reduced disability-adjusted life-years. About 80% of all strokes are ischaemic. Recombinant tPA is the most biologically effective treatment for acute ischaemic stroke that, although not reducing mortality and having potentially serious side-effects, greatly reduces disability in stroke sufferers. Because of the relatively short therapeutic time window and a worldwide shortage of physicians who are experts in acute stroke management, at present only around 5% of stroke sufferers receive tPA treatment.
Together with increasing the therapeutic time window, the use of efficient tPA triage pathways and identification of factors associated with treatment delays provide an important avenue for making tPA treatment more accessible when it is clinically indicated. Thus, it is of little surprise that the issues of design and implementation of acute stroke thrombolysis pathways present an important research and practical challenge for health care delivery systems.
Value-focused Process Engineering (VFPE) is a novel goal-oriented process modelling methodology that provides a structured way of using systems' objectives to guide the design and evaluation of systems' processes, thus providing a scope for addressing both efficiency and effectiveness concerns of systems' operations in an integrated manner. In this presentation we demonstrate how VFPE can be used to create a comprehensive conceptual clinical process model for an acute stroke thrombolysis pathway. We also discuss the role of VFPE as a problem structuring tool and its use as a basis for pathway simulation and clinical decision support.

Keywords: Decision support systems for health care, Clinical pathways modelling, Value-Focused Process Engineering, Conceptual Modelling, Health Providers.

TH1_A

A Continuous Time Bayesian Network model for cardiogenic heart failure.

Elena Gatti[1], Davide Luciani[2], Fabio Stella[1]

[1] *Dipartimento di Informatica, Sistemistica e Comunicazione, Università degli Studi di Milano-Bicocca, Italy*
{elena.gatti, stella}@disco.unimib.it

[2] *Laboratorio di Epidemiologia Clinica, Istituto di Ricerche Farmacologiche Mario Negri, Italy*
davide.luciani@marionegri.it

Over the last twenty years several research programs have been developed to assist physicians in reasoning about cardiovascular disorders, which provide a challenging domain for diagnosis. The proposed approaches were logic based models and Bayesian Networks and later Dynamic Bayesian Networks (DBNs), a factored

representation of discrete-time processes, to cope with both temporal and severity reasoning. In this contribution the authors propose a further shift from DBNs to Continuous Time Bayesian Networks (CTBN), an elegant modeling language for structured stochastic processes that evolve over continuous time. CTBNs improve the expressiveness and computational efficiency of DBNs. Indeed, CTBNs explicitly represent temporal dynamics and thus allow us to recover the probability distribution over the time when specific events occur. The main advantage of the framework described is that they allow to model systems where there is no natural time granularity and where the states of some variables vary over time, according to different time scales.
A detailed model is provided which overcomes the strong modeling and computational limitations of DBNs. The model, specified by the domain experts, consists of several physiological, clinical and unobservable variables which are the focus of the myocardial infarction diagnosis and prognosis task. In literature there are not such an extended modeling frameworks with the aim of reasoning about cardiovascular disorder.
Some examples showing how the proposed model can be used for early analysis of patients are reported. The inference examples include point evidence, usually available also in DBNs, and interval evidence, which is one of the main modeling advantages of CTBNs.
The model described would be attractive in order to compute the expected time of staying in a particular state of interest or to calculate the joint distribution of two events and the issue of taking some decisions under uncertainty can be a challenging future work.

Keywords: Decision support systems for health care, Probabilistic graph models, Continuous time Bayesian networks, Patients.

TH1_A

Modelling the impact of extending the onset to treatment time of thrombolysis for acute ischaemic stroke from 3 to 4.5 hours.

Martin Pitt

Peninsula Medical School, Exeter, UK.
martin.pitt@pms.ac.uk

The use of thrombolysis is a clinical proven approach for the treatment of acute ischaemic stroke. The effectiveness of this treatment, however, depends critically on how quickly it can be administered. Current licensing for the administration of thrombolysis in the UK is limited to a period of up to 3 hours after onset of stroke. Various studies, however, have concluded that benefits might be gained by extending the Onset-to-Treatment (OTT) duration for thrombolysis to 4.5 hours. Against this, it has been argued that an extension to the OTT deadline might militate against the necessary sense of service urgency and adversely affect behaviour of service providers. In order to explore the potential trade-offs implied by an extension of the OTT deadline for the thrombolytic treatment of stroke, a state-transition model of stroke care pathways was constructed and parameterised using existing hospital stroke timing and effectiveness data. The model was then used to explore the likely outcomes for a range of viable scenarios of system response in comparing a 3 hour versus a 4.5 hour OTT deadline for treatment and examine the implied trade-offs inherent in this time extension.

Keywords: Stroke, Thrombolysis, State-Transition Modelling.

Advanced models

TH1_B

Funding long term care

Amedeo Fossati, Marcello Montefiori

Department of Economics and Quantitative methods, University of Genova, Italy
fossati@economia.unige.it, montefiori@unige.it

Social expenditure for the elderly care is doomed to rapidly increase in next years in most industrialized countries, since population ageing is a widespread phenomenon.
Among the countries of the European Union, Italy is one of the "oldest" with a rate of aged population (people over 65) around 20% of the entire population. A scenario even more alarming is represented by Liguria (a Region of Italy) in which the aged population counts about 27%. This paper derives optimal transfer policies for the funding of elderly care. It is assumed that elderly family members in need of care vary in severity, where higher severity implies a higher (marginal) cost, as measured by the time required to bestow any given caring benefit. The paper provides the optimal allocation of caring benefit and consumption from the household's perspective and examines how a utilitarian policy-maker should choose a tax-funded transfer in order to support either of the two family types (with dependents of high or low severity). The solution is derived both for the case where the policy-maker has complete information about severity and for the case where severity is the family's private information. The effects of different funding rules are examined.
This study consistently differs with respect to the current literature on long-term elderly care both in terms of settings and results. In comparison with the current literature, the present paper contributes to the topic in two ways. Firstly, it points out that social welfare maximization might require income transfer not always from the high to the low cost household, but at times from the low to the high cost one. Then, we are able to highlight the conditions which call for such a transfer in a fairly general setting, where no particular assumptions on utility and cost function are required. Secondly, in an asymmetric information scenario, we show how the social planner might be limited by incentive compatibility constraints, but also which policy the social planner might implement in order to attain a second best outcome.

Keywords: funding, resource allocation, elderly care, optimization under uncertainty, health social planner.

TH1_B

Health Care in Italy: Expenditure Determinants and Regional Differentials

Maura Francese, Marzia Romanelli

Structural Economic Analysis Department, Banca d'Italia, Italy
{maura.francese, marzia.romanelli}@bancaditalia.it

Health spending represents a significant share of public and private budgets in Italy as in the majority of developed countries. Public health expenditure accounts for about 7% of GDP and it has been growing faster than income. Given the expected population ageing, it is likely that spending will continue to rapidly increase, raising serious challenges to the sustainability of public finances. The aim of this work is to identify the determinants of spending differentials among Italian regions, which could highlight the existence of potential margins for savings. The analysis exploits a dataset for the panel of the 21 Italian regions starting in the early nineties and ending in 2006. The paper presents an empirical analysis of per capita expenditure

levels and differentials. The results suggest the existence of potential margins for savings which are related at least in part to differences in the effectiveness of public administration. In particular, after having controlled for standard health care demand indicators, spending differentials appear to be associated with differences in the degree of appropriateness of the treatments, supply structure and social capital indicators. These results suggest that savings could be achieved without reducing the amount of services supplied to citizens. The degree of inefficiency does not seem to be evenly distributed among spending items. Some spending categories, such as outlays for pharmaceuticals, need particularly careful monitoring in the regions displaying relatively high levels of inefficiency. Fostering the use of best practices (such as the use of generics or policies that decrease inappropriateness indicators for the hospital sector) would enhance the efficiency in the use of public funds.

Keywords: Planning health services/care, Resource allocation in health care, Statistical (econometric) analysis, System (Region & National).

TH1_B

On the financial health of Italian hospital facilitators: an empirical investigation through correlation-based networks

Marina Resta

DIEM, University of Genova, Italy
mresta@unige.it

It is a matter of fact that health care expenditure plays a crucial impact into financial resources of a country. As a general (mis)believing, the higher the budget allocation to hospital facilitators (clinics, regional or local community hospitals, medical centers) is, the higher should be the overall quality of services they provide, and their probability to reach their financial goals without any additional external intervention . Starting from this point, we try to offer new insights to the subject, by examining the balance score of 300 Italian public hospital facilitators (HFs), using that data to build a network. In such network, nodes are HFs, and each pair of them is connected by an arc whose weight is related to the cross-correlation coefficient between the corresponding HFs balance scores. By connecting all the vertices through the most correlated link, without forming any loop, we have obtained the Minimum Spanning Tree (MST) on data. We were then able to provide a quite unusual representation of the overall financial situation of Italian HFs, observing the emergence of very surprising patterns: in our opinion, those could be of help to policy makers, in order to realize a more efficient allocation of financial resources among the existing HFs. We also tried to suggest some possible economic interpretations of the results coming from standard networks analysis (i.e. the analysis of average length of shortest path, betweeness, and degree), in two different ways: (i) through the sensitivity analysis of networks obtained by changes in the variables of the balance score to be considered; (ii) by examining the results in a dynamic frame, i.e. by comparison of graphs formed using balance scores of different years.

Keywords: Evaluation in health care, Allocation of financial resources to hospital facilitators, Graphs, Correlation networks, Minimum spanning tree, System, Health providers.

TH1_B

Measuring the Inefficiency of Choice

Vincent Knight

School of Mathematics, Cardiff University, UK
knightva@cf.ac.uk

The NHS has offered free choice of healthcare service to all patients in England since 2008. Modelling the behaviour of patients in a system with free choice is very important. Competitive location analysis aims to capture this sort of behaviour and has been widely used in the commercial sector.
One particularity of healthcare systems is the importance of congestion and the potential strain that choice can put on waiting lists and lengths of stay. The approach taken in this talk is to use notions of Game theory and Traffic Flow theory to measure the inefficiency that appears due to choice: "*the Price of Anarchy*".
This talk is mostly theoretical but with numerous results having very real interpretations. If one result alone is to be taken from the work presented here it is that in general "*selfish users make busier systems*".

Keywords: Choice, Game Theory, Traffic Flow, Queuing Theory, Patients.

Simulation

TH1_C

Assessing different deployment plans of a colorectal screening programme through discrete event simulation

Karen J. Cairns, Christine R. Allen, Adele H. Marshall

Centre for Statistical Science and Operational Research (CenSSOR), Queen's University Belfast, UK
k.cairns@qub.ac.uk

Discrete Event Simulation (DES) models, built as decision support tools for health care providers, can help decision-makers in investigating the optimal arrangements of current health care provision as well as the impact of possible additional health policy measures. A colorectal screening programme is currently being introduced in Northern Ireland, with gastrointestinal (GI) endoscopy Day Procedure Units (DPUs) being expected to undertake over 900 additional lower GI tract endoscopy procedures each year across Northern Ireland as a result of this programme. In this research, a DES model has been built to mimic the current operation of an endoscopy DPU in one hospital, so that the effects of different deployment plans of the colorectal screening programme can be investigated.
The DES model tracks each individual's pathway, from the time of their requesting treatment through to the delivery of treatment. The creation of patients is modelled as a stochastic process, to mimic the 1550 lower GI tract endoscopy and 3600 other procedures currently being carried out across the 3 theatres of the DPU. Patient characteristics considered include their in-/out-patient status, their routine/expedited status, and procedure type (e.g. upper/lower GI tract endoscopy). The model accounts for the block-scheduling of out-patients via the various doctor lists, which in turn influences the scheduling of in-patients. The flow of patients through one of the 3 DPU theatres to the recovery room is based both on patient characteristics and possible resource constraints.
The DES model was validated through examination of e.g. its activity levels, theatre/recovery times, waiting-list times. To assess the various deployment plans, statistics output include, the utilisation of lists, the volume of doctor overtime, and the numbers of patients being rescheduled. Results suggest that while the screening programme is initially being run based on dedicated screening lists, policymakers should also consider targeting underutilised doctor lists.

Keywords: Decision support systems for health care, Colorectal screening., Discrete event simulation, Health providers.

TH1_C

Simulating the impact of a 45% increase in patient volume at Akershus University Hospital

Lene Berge Holm, Fredrik A. Dahl

Helse Sor-Ost Health Service Research Centre, Akershus University Hospital, Norway
{lene.berge.holm, fredrik.dahl}@ahus.no

Background: Hospital patient flow resulting from a significant increase in patient volume is difficult to predict. This is a key issue when Akershus University Hospital, which is a Norwegian 615-bed hospital serving 340,000 inhabitants, increases its catchment area by 45% in 2011.
Aim: In order to make qualified decisions on the necessary increase in hospital beds, staffing and other resources resulting from the upcoming patient volume increase, the hospital management is in need of adequate tools for estimating consequences of this. This will be evaluated in this study by use of simulation models.
Method: A simulation model of the hospital at large is developed. Patients are separated into different categories according to acuity and disease, with statistical distributions of length of stay (LOS) dependent on this. Data is obtained from the patient database from 2009. In the preliminary model the hospital is divided into five main wards; surgery, intensive care, heart/lung, infection and general medicine. The arrival rates and LOS distribution in the Emergency Department (ED) are based on a detailed ED simulation model presented at WSC09.
Findings and implications: The model is still under development and validation, but the preliminary results show that increasing the patient volume by 45% may lead to severe overcrowding if the only adjustment is 100 additional beds. The optimal solution appears to be to increase the bed capacity to an extent which gives an occupancy rate around 85%. A higher occupancy rate may lead to overcrowding of the patient rooms, or it leads to storing of patients in the corridor. It is therefore important to take the results of this simulation analysis into consideration when the decision of increase in beds and staffing is made.

Keywords: Patient flow management, Simulation, Health providers.

TH1_C

Simulation Project for an Ear-Nose-Throat Clinic

Sule Kaya[1], Elcin T.Cakmak[1], Murat M.Günal[2], H.Kemal Sezen[1], Selcuk Onart[1]

[1] *Department of Econometrics - Uludag University, Bursa, Turkey*
kemal@uludag.edu.tr

[2] *Department of Industrial Engineering - Turkish Naval Academy, Tuzla, Istanbul, Turkey*
mgunal@dho.edu.tr

Outpatient clinics are one of the points in hospitals where different types of waiting occur; on appointment system waiting and on clinic waiting. The first is mostly related to the appointment system where patients are given date and time for a clinic visit. Although there are studies on this type of waiting, the literature has given more attention to the second type. Simulation is one of the methods used to evaluate waiting time performance in clinics. In this study we present a case study which we built a discrete event simulation model for an Ear-Nose-Throat outpatient clinic of a hospital in Turkey. We analysed historical electronic data and examined resource utilisation in the clinic. We developed process flow diagrams with the clinic staff and related with the services provided. The results of our preliminary data analysis show that private patients wait less than control patients. Using this model, we studied waiting times of patients in different stages and specified the bottlenecks in the clinic.

Keywords: Performance measurement/evaluation in an ENT clinic, Simulation (Discrete Event), Patients, Doctors, Clinic managers.

TH1_C

Considering Combining: Exploring a mixed approach of SD and DES to develop understanding within an Oncology Unit

Jennifer Morgan, Susan Howick, Valerie Belton

Department of Management Science, University of Strathclyde, Scotland, UK
Jennifer.s.morgan@strath.ac.uk

Both System Dynamics (SD) and Discrete Event Simulation (DES) are popular Operational Research (OR) approaches used to model healthcare systems. DES has been widely used to develop understanding of and refine processes, often with the focus at the operational level and on the individual patient experience through the system. SD allows for the representation of the dynamics of the system, and feedback processes; often presenting insight at a more strategic or policy level. This work is focused on considering how the combined use of both approaches could provide complementary insight and develop problem holders understanding of their systems within an Oncology Unit in Scotland. It proposes that the problem system is explored with a broad view of possible solution approaches, and how these approaches may be used in combination. The current stages of the processes undertaken to model the system are discussed, and the impact of embarking upon a mixed approach intervention are considered. The current state of the model development work and provisional outputs are discussed. The intervention seeks to provide problem holders with the opportunity to explore their system at numerous levels of detail and to think about their system in a different way. The benefits to be had from exploring the system in this way are considered, along with the need to challenge the inherent beliefs about the structure of the system.

Keywords: Patient flow management, Decision support systems for health care, Simulation, System Dynamics, Health providers (Unit & Hospital).

EMS (2)

TH2_A

A Petri nets model for the analysis and the evaluation of an EMS

Roberto Aringhieri[1], Marco Gribaudo[2]

[1] *Dipartimento di Informatica., Università di Torino, Italy*
roberto.aringhieri@unito.it

[2] *Dipartimento di Elettronica e Informazione, Politecnico di Milano, Italy*
gribaudo@elet.polimi.it

The quality of the health care is directly connected to the effectiveness of the service delivered. Usually, the health care is delivered by crews or team composed of individuals working together sharing knowledge, experiences and skills. Therefore, teams having different individuals can directly affect the effectiveness of the whole system providing the health care service. We can measure the efficiency of the teams and of the members involved using various metrics (such as the number of patient per hours they visits, or the

probability of making an incorrect decision), and exploit such measures to forecast the overall performance of the team. The random nature of the problem however, requires the introduction of random variables, and the characterization of the overall team behaviour with some sort of stochastic process.
In this paper, we consider the impact of different team composition analysing the patient flow of an Emergency Medical Service (EMS) by using a detailed Generalized Stochastic Petri nets (GSPN) model. A GSPN allows a direct mapping from a high level representation of the team and of the EMS, to a Continuous Time Markov Chain (CTMC) that can be analyzed to evaluate the performance of a particular choice. With a careful simplification of the EMS process, the solution of the GSPN and the evaluation of the performance metrics can be performed at a speed high enough to consider the model as a black box for an upper level optimization procedure.
The GSPN model takes into account both the characterization of the members of the team (by exploiting parameters obtained from the statistics on their previous activities), and of the specific situation in which the team is going to operate (by appropriately defining the rates and the nature of events the team is going to face).

Keywords: Patient flow management, Stochastic Petri nets, Patients.

TH2_A

Emergency Process Improvement By Lean At Kashani Hospital in Isfahan, Iran

Saeedeh Ketabi[1], Sima Ajami[2]

[1] *Department of Management, University of Isfahan, Iran*
sketabi@yahoo.com

[2] *Department Medical Records, Isfahan Medical Sciences University, Iran*
ajami@mng.mui.ac.ir

Hospitals around the world are successfully implementing Lean methods for the benefit of patients, employees, physicians, and the hospital organizations. Standardized Work, visual management, and other Lean management concepts are used to improve communication and prevent errors caused by handoffs across caregivers and departments. Lean improvements through Standardized Work, layout and flow improvements, are reducing waste and non-value added time. This paper describes how Emergency Department(ED) at Kashani Hospital in Isfahan, Iran applied Lean Applications to improve its processes. Kashani Hospital is a teaching hospital with more than 30000 annual number of admission for ED. After reviewing the result of a recent project "Reducing the waiting times at ED of Kashani Hospital by Simulation", the discussion with the management shifts to a Lean Healthcare Vision focused on reducing non-value-added procedures and waiting. The Lean team used flow diagram to map ED processes in order to first find out how different departments interfere in serving patients, and then redesign the processes based on the standards.Different types of waste or *Muda* have been observed; a few of them are :

- *defects* in radiography films and *overprocessing* in radiology;
- *overproduction* of lab results and delay in *tranporting* them to the admit division;
- *waiting* of critical patients, as there is no triage at the department, lack of the flow of *information* regarding patients throughout the admit division;
- *skills* which are required since at such a teaching hospital, physicians are mostly interns who do not have the sufficient authority, and residents who attend part time;
- *motion* in nurse's rework and searching for physicians or supplies.

Lean improvements were proposed through team-discussion and from eliminating waste and delays, supporting those who do the value added work. Lean is going to be a cultural change and a management system.

Keywords: Emergency, Process improvement, Lean management, Waste, Value added procedure.

TH2_A

Optimisation of patient flows at emergency departments

Erhan Kozan

Mathematical Sciences, Faculty of Science and Technology, Queensland University of Technology, Australia
e.kozan@qut.edu.au

The Emergency Department (ED) is a non-terminating dynamic large complex system with limited specialised resources and high levels of stochastic demands. The interactions between the resources increase the complexity of the system. The system is complex further by external factors and it is thought to be related to the combined effects of growth in demand, blocked access to inpatient beds and other departments, staff shortages and possibly system layout and coordination. The ED should determine how best to process through a number of resources (beds, doctors, nurses, equipment, etc.) in a set order or routing a number of different patients which have different processing times on each resource. This paper adopts specifically resource-constrained sequencing and scheduling techniques in an ED environment to find the sequence, schedule and accompanying resource allocation that maximise the ED usage. This more realistic approach is extremely difficult to solve and has in fact proven to be computationally intractable NP-hard (NP-complete) and needs to innovative solution techniques. Therefore scheduling heuristics are developed to solve this complex problem. A numerical investigation is presented and demonstrates that high quality solutions are obtainable for industry-scale applications.

Keywords: Resource allocation in health care, Heuristics, Metaheuristics, Health providers.

TH2_A

Predicting Emergency Medical Service Demand in Wales using Singular Spectrum Analysis

Julie Williams[1], Paul Harper [2], Jonathan Gillard [2], Vincent Knight[1]

[1] *School of Mathematics, Cardiff University, Senghennydd Road, CARDIFF, Wales, UK.*
WilliamsJL5@cardiff.ac.uk

[2] *School of Mathematics, Cardiff University, Senghennydd Road, CARDIFF, Wales, UK.*
{Harper, GillardJW}@cf.ac.uk

Previous studies have examined ways to improve the effectiveness of the emergency medical service (EMS), with particular developments in the fields of ambulance deployment and personnel scheduling. Whilst the models created differ in complexity, they all require accurate predictions of demand: the focus of this research is how to effectively generate such forecasts. Traditional forecasting techniques such as multiple linear regression are commonly employed for this purpose, whilst time-series approaches may be utilised to overcome difficulties relating to multicollinearity and the selection of valuable covariates.
We consider a novel time-series approach to predicting demand exerted upon the Welsh Ambulance Service Trust (WAST) using Singular Spectrum Analysis (SSA) and compare the results to those obtained by traditional forecasting techniques. Ultimately we aim to investigate relationships between demand and weather conditions to improve predictions, and use forecasts generated via SSA for input to a queuing model to determine how best to respond to demand. Further applications include developing a scheduling tool to generate rosters for personnel and response vehicles, to promote proactive management of the service.

Keywords: forecasting ambulance demand, time series, singular spectrum analysis, academic.

Planning health services (3)

TH2_B

Lessons from Parallel SD Model-Building for National and Local Projects

Timothy Bolt[1], Steffen Bayer[2], Maria Kapsali[2], Sally Brailsford[1]

[1] *School of Management, University of Southampton, UK*
{tim.bolt, s.c.brailsford}@soton.ac.uk

[2] *Business School, Imperial College London, UK*
{s.bayer, m.kapsali}@imperial.ac.uk

This study reports on parallel modelling observations and follow-up interviews for two System Dynamics model-building exercises covering the same problem and decision area. One was developed by a national team for local commissioners across the country and the other by a local team (UK NHS PCT) for its own use in commissioning for that particular jurisdiction. While both adopted the same basic facilitated multi-meeting expert group model-building process, this paper considers the differences in the modelling and the model role which result from the difference in the expert group participation and the expected users of the resulting model.

The analysis of the model-building observations and follow-up focus primarily on the different 'object roles' (boundary object, epistemic object, representational object & technical object) which the model can take during the group development process based on its use in facilitating communication, enabling learning, policy evaluation, etc. The use of the model shifted over the development cycle as well across the two observed parallel projects. Among the initial results highlighted in the paper is the locally-built model for internal-use being characterised by a more of a role for knowledge sharing and knowledge creation and how the national tool-building exercise reflected the technical and representational roles for the model. This was based on two factors: intended final usage mode for the resulting model and the characteristics of the experts brought in for the two exercises.

As well as documented differences in sourcing data, model detail, development practices and model adaptability; among the key differences was also the stakeholder engagement and the participant interactions in the two exercises and how this fundamentally directed the interactions and object roles which the model needed to fill.

Keywords: Planning health services, Systems dynamics, Group model building, System (National & PCT comparison).

TH2_B

A tool for supporting Health Service Re-design decisions

Thierry Chaussalet, Eren Demir, Salma Chahed, Farid Fouladinejad

Health and Social Care Modelling Group, University of Westminster, London, UK
{chausst, demirer, chaheds}@wmin.ac.uk, farid.fouladinejad@hounslowpct.nhs.uk

Primary care is the care provided by people we normally see when we first have a health problem. It may just be a visit to your local doctor, dentist, or an optician for an eye test. In England, all of these services are managed and commissioned by local primary care trusts (PCTs) on behalf of the National Health Service (NHS). Currently, general practice (GP) doctors deliver primary care services by providing treatment and drug prescriptions and where necessary patients are referred to specialists, such as for outpatient care, which

is provided by local hospitals (or specialised clinics). However, general practitioners (GPs) are limited in terms of size, resources, and the availability of the complete spectrum of care within the local community. With the re-design of primary care services, GPs will be based at polyclinics, where the range of services available is expected to exceed that of most existing GP practices. Along with GP practices, polyclinics will also provide range of outpatient services. These changes have caused a number of concerns to Hounslow PCT. For example, which of the outpatient services are to be shifted from the hospital to the polyclinic? What are the expected current and future demands for these services? To tackle some of these concerns, the first phase of this project explores the set of specialties that are frequently visited in a sequence (using sequential association rules). The second phase develops an Excel based spreadsheet tool to compute the current and expected future demands for the selected specialties. Endocrinology and ophthalmology were found to be highly associated, where these two specialties could easily be shifted from the hospital environment to the polyclinic. Based on historical data, we developed a spreadsheet model that allows PCT managers to estimate the parameters, which will be used then to provide current demand and growth projections for various age groups. We illustrated the model for endocrinology and ophthalmology, however, the model is generic enough to cope with other situations, provided that the data are available.

TH2_B

A metamodelling approach to health care system management

Maria Pia Fanti[1], Giorgio Iacobellis[1], Walter Ukovich[2]

[1] *Dipartimento di Elettrotecnica ed Elettronica, Politecnico di Bari, Italy*
{fanti, iacobellis}@deemail.poliba.it

[2] *Dipartimento di Elettrotecnica, Elettronica e Informatica, Università di Trieste, Italy*
ukovich@univ.trieste.it

Providing high quality healthcare calls for improved organization and management in Health Care Systems (HCSs) such as hospital departments. In such systems the main problems to face may be classified as follows: i) dimensioning the system, i.e., determining the type and number of resources to provide (staff, rooms, beds, etc.); ii) understanding the workflow and detecting anomalies such as bottlenecks, waiting times, etc.; iii) improving efficiency, i.e., using resources in a better way, by decreasing patients length of stay, reacting to problems such as staff absence, etc.; iv) studying the system reactivity with respect to an increased workload.

The introduction of ICT technologies in healthcare systems aims at monitoring all data for patients admitted to hospital and it is expected to improve data accessibility, completeness, risk analysis, reduced errors and increased rational monitoring of paper filling. In this context, simulation and performance evaluation provide a useful tool for capacity planning, workflow and patient flow management and efficiency improvement.

In order to describe a generic HCS from the structural and behavioural point of view, this paper shows a metamodelling approach, that in other words is an accurate description of the construct and rules needed to obtain models encapsulating all concepts necessary to describe a particular system. The proposed approach consists in applying a top down procedure based on the well known UML formalism, a graphic and textual modelling language to understand and describe systems from various viewpoints. In order to illustrate the metamodelling procedure, a real case study representing a department of an Italian hospital is considered. By means of UML diagrams, we first describe the structure of a generic HCS and we subsequently propose the model of the hospital department, showing the most important entities that compose them (called classes). Moreover, we employ activity diagrams to specify some basic hospital activities. The aim of the model is twofold: i) proposing a simple tool that can be translated into a simulation software; ii) building a reference model that reproduces the HCS evolution in order to supply the a management system with the knowledge base for decisions and planning.

Keywords: Planning health services/care, Resource allocation in health care, Decision support systems for health care, Simulation, System dynamics, Health providers (Unit & Hospital).

TH2_B

A software tool for assisting with the reconfiguration of the UK mental health services

Christos Vasilakis[1], Christina Pagel[1], Steve Gallivan[1], David Richards[2], Martin Utley[1]

[1] *Clinical Operational Research Unit, University College London, UK*
{c.vasilakis, c.pagel, steve.gallivan, m.utley}@ucl.ac.uk

[2] *School of Psychology, University of Exeter, UK*
d.a.richards@exeter.ac.uk

In this paper we describe a software tool that has been developed with the aim of assisting those responsible for introducing the stepped care system design to the UK mental health services. Under this design, many patients presenting with common mental health problems are initially offered some kind of low intensity therapy, ahead of more intensive forms of therapy if deemed necessary. As intended users of the tool would not have data pertaining to their own services, the tool is predicated on the use of data collated from a number of sites across the UK that piloted the stepped care system design. The tool allows the user to design alternative system configurations, or scenarios, comprising a number of care activities and end points, and match them to analogous pilot sites. Output is generated using two mathematical models, both representing mental health care services as a network of servers. The first model concerns traffic intensity for each server within the network reflecting average weekly demand for each clinical activity. This is used to provide the user with a planning summary which includes the expected weekly demand for appointments, the ratio of demand to appointments offered, and a range for the number of appointments suggested by the given workload. The second model, which is based on the observation that such systems would most likely operate at full capacity with long waiting lists is used to provide the user with a summary of system performance over a 6-month period. Performance measures include ranges for the expected throughput, the expected change in waiting list size, and the expected change in waiting times.

Keywords: Planning health services/care, Decision support systems for health care, Mathematical modelling, Queuing theory, System.

Staff planning and scheduling

TH2_C

Modeling nurse-to-patient assignments on a hospital unit

Ilgin Poyraz Acar[1], Steven E. Butt[2]

[1] *Department of Industrial Engineering, Anadolu University, Turkey*
ipoyraz@anadolu.edu.tr

[2] *Department of Industrial and Manufacturing Engineering, Western Michigan University, Kalamazoo, Michigan, USA*
steven.butt@wmich.edu

Heavy workloads have been identified as a major cause of job dissatisfaction among hospital nurses and may ultimately lead to a reduction in the quality of care that is provided to patients. There are many factors that add to nurses' workloads and many of these factors are tied to their assigned patients. In addition to balancing direct patient care needs among the nursing staff, total workload balance must consider indirect patient care, which is affected by the layout of the hospital unit and the location of a nurse's assigned

patients. This is particularly true in hospital environments consisting of single patient rooms, since a nurse's assigned patients may not be in close proximity to one another or to critical facilities on the unit. To optimize nurse-to-patient assignments, a mixed-integer programming model was developed based on the patient and unit requirements of a general medical hospital unit consisting of single patient rooms. Using the Analytical Hierarchical Process (AHP), measures of "good" and "balanced" assignments were developed through consultation with the charge nurses on this unit. With these measures a new patient acuity scoring system and a distance scoring system were developed. The distance scoring system was used to indicate the total relative distance a nurse would traverse during her shift based on a given set of assigned patient rooms. The resulting nurse-to-patient assignments were found to be as good, or better, than the assignments produced manually by the unit charge nurses. Results also indicated that the variability of the nurse-to-patient assignments were greatly reduced in terms of total nurse workload, total patient workload, and total distance traveled during the shift. This work is the first to explicitly consider incorporating travel distances into the construction of a nurse's patient assignment and to use AHP to define the importance of each workload measure.

Keywords: Manpower, Staff scheduling, Planning health services/care, Integer programming, Health providers (Unit & Hospital).

TH2_C

Flexible personnel scheduling in Healthcare

Julien Crowe, Patrick Soriano

Méthodes quantitatives de gestion, HEC Montréal, Canada
{julien.crowe, patrick.soriano}@hec.ca

It is widely recognized that continuous service operations (24h/day) make many healthcare personnel scheduling problems challenging to solve. Furthermore, large sets of often conflictual constraints emanating from worker unions agreements (such as in nurse applications) or personal preferences (such as in emergency room physicians applications) increase the complexity of these problems. Much attention has already been given to such issues in OR literature. However, little interest has been focused on portability of personnel scheduling solution methods until recently.

Indeed, solving complex problems frequently means time-consuming solution method development. In order to save time on the short term, too often we sacrifice flexibility (and hence portability) and produce a solution method which is only useful for solving a problem limited to one specific application. Consequently, we must go through the very time consuming process of creating a new solution method each time a significantly different problem arises. And sadly, in Canada, most personnel scheduling problems in healthcare applications qualify as being significantly different from one another : This is not only true for different types of personnel or facilities, but also for most personnel working in different sections of the same facility.

At ORAHS 2010, we present an improved version of SOFA (schedule optimizer with a flexible approach), an algorithm with the objective of providing good solutions on a large number of different healthcare scheduling problem applications (nurses, physicians, paramedics, etc.) This algorithm's core (initially presented at ORAHS 2009) was built to benefit from basic structures encountered in most healthcare personnel scheduling applications. Furthermore, robust heuristic mechanisms are integrated to provide quality solutions on a variety of problem structures. Finally, we present results on reality-inspired and extreme theoretical problems, as well as on real-life instances from Canadian healthcare applications.

Keywords: Personnel scheduling, Sequential heuristic, Flexible algorithms, Management.

TH2_C

Optimal personnel planning and admission scheduling in rehabilitation facilities

Paulien Out, Sandjai Bhulai

Department of Mathematics, VU University Amsterdam, The Netherlands
{paulien, sbhulai}@few.vu.nl

Rehabilitation facilities are faced with restricted budgets and an increased demand for care at the same time. This development poses challenges to service all patients with fewer funds while still meeting their quality standards. One of the most urgent questions in this setting is how to balance the workforce with different specialisms so that capacity meets demand in the best possible way within the budget constraints.
In this work we model the workforce planning problem for rehabilitation facilities as a discrete-time Markov decision chain. The available man-hours per week for each specialism are modelled as the number of available servers. The patients require several servers simultaneously for a given number of hours per week, which is determined by a probability distribution. We address how patients should be serviced optimally so that the utilisation of the capacity is maximised and the demand is met.
The proposed model is a generalisation of the stochastic knapsack model. Standard solution techniques cannot be used due to the large state space of the model for realistic instances. Therefore, we develop approximate dynamic programming techniques to analyse and control the system. The proposed algorithm is scalable in the size of the problem instance and generates near-optimal policies. Extensive numerical studies demonstrate the effectiveness of this technique.

Keywords: Rehabilitation planning, Personnel scheduling, Markov decision chains, Approximate dynamic programming, Rehabilitation facility.

TH2_C

Do what must be done: no more, but certainly no less

Egbert van der Veen, Bart Veltman

Department of Applied Mathematics, University of Twente, The Netherlands & ORTEC bv, The Netherlands
{Egbert.vanderVeen, Bart.Veltman}@ortec.com

In health care, as in most other service industries, the workload varies on a daily basis. As an immediate consequence, the demand for workforce capacity, the number of staffed employees, varies on a daily basis. Within the Dutch practice of employment, the workforce capacity is of a far more constant nature. Employees have contracts that give them (some) protection against being fired. However, Dutch legislation on labor times and different forms of labor contracts – such as full time, part time, min-max contracts – allow for some flexibility, some dynamics in workforce capacity over time, without changing the number of staffed employees.
We propose an ILP model that determines the optimal workforce from a given pool of workers and a given workload that has to be covered. The model includes multiple forms of labor contracts, different skills, expected holidays and absence days. The workload is defined for a series of time slots (such as days, weeks or months) and distinguishes different skills. Next to the optimal workforce, the model also produces a workforce capacity plan, indicating per employee, per time slot and per skill how much working time the employee is expected to produce.

Keywords: Resource allocation in health care, workforce dimensioning, (Mixed) integer linear programming, Health providers.

EMS (3)

TH3_A

A new maximum reliability model for locating and dispatching ambulances

Roberto Aringhieri[1], Maria Elena Bruni[2]

[1] *Dipartimento di Informatica., Università di Torino, Italy*
roberto.aringhieri@unito.it

[2] *Dipartimento di Elettronica, Informatica, Sistemistica,Università della Calabria, Italy*
mebruni@deis.unical.it

This paper addresses the problem of designing reliable emergency medical services. According to the literature, an EMS is said to be reliable if, when a service demand arises, there is at least one vehicle ready to provide service. Thus, the reliability is measured by the ability of the emergency service to guarantee a high level of service by covering the random requests within a given time limit.
Clearly, the main issue to consider is the inherent uncertainty which characterizes real life situations, involving random ambulance travel times and random emergency calls arrival. Models that do not account for the uncertainty in these components may overestimate the possible service level for a given number of ambulances and underestimate the number of ambulances needed to provide a specified service level. However, designing an EMS with a reliability of 100% is often impracticable for economic reasons and would result in significant over-capacity much of the time since worst-case situations typically occur with a low probability.
In order to deal with this trade-off, a new probabilistic model is proposed within the stochastic programming framework which integrates the use of probabilistic constraints within a two-stage structure.
The model solves the ambulance logistic problem determining simultaneously the location and dispatching problem, determining the number of vehicles to be housed at a given pre-existing station and which ambulance to send to a given call.
In particular, the scenario based model chooses the number of ambulances to be housed in each station before knowing the random travel times and emergency calls occurrence. After the realizations of the random parameters become known, the ambulances can be dispatched so that the emergency requests can be serviced on time.
By incorporating randomness in travel times and emergency calls requests, the proposed model can accurately model the behaviour of real systems.

Keywords: Problem addressed: Logistics of health services, Stochastic programming, System.

TH3_A

A re-optimization approach applied to emergency medical services management

Valérie Bélanger[1,4], Angel Ruiz[2,4], Patrick Soriano[1,4], Roberto Wolfler Calvo[3]

[1] *HEC Montréal, Department of Management Sciences, Canada*
{valerie.3.belanger, patrick.soriano}@hec.ca

[2] *Université Laval, Operations and Decision Systems Departement, Canada*
angel.ruiz@osd.ulaval.ca

[3] *Université Paris Nord, Computer Science lab of the Paris Nord University (LIPN), France*
roberto.wolfler@lipn.univ-paris-13.fr

[4] *Interuniversity Research Center on Enterprise Networks, Logistics and Transportation (CIRRELT), Canada*

Emergency medical services are faced daily with uncertain service requests. The state of the system can evolve in an unpredictable way throughout the day and some corrective actions may be needed to maintain an adequate service. The dynamic redeployment of ambulances is one of these actions which seek to relocate available ambulances when the state of the system changes and requires it. Although an interesting way to provide good service at all times, relocation of vehicles generates movements that may lead to undesirable consequences both from economical and human resources management standpoints. Therefore, relocation decisions should be taken in order to regain a good service level but also to modify as little as possible the current deployment plan. Given the currently implemented solution to a particular problem, called *reference solution*, re-optimization consists in finding the optimal or at least a good quality solution to a modified version of that problem (i.e. where some of its parameters have changed) while controlling the amplitude of changes with respect to the reference solution. Considering this definition, the redeployment of ambulances lies within the framework of re-optimization. We propose two models for the dynamic relocation of ambulances based on the re-optimization approach we developed in a recent study. The first model seeks to determine where to locate each available ambulance considering practical concerns due to redeployment. The second still aims at determining the location of each available vehicle, but taking explicitly into account the assignment of potential service requests to vehicles after relocation. These two models attempt to maximize the *preparedness*, defined as the ability to serve potential requests now and in the future. Each of these approaches can be used at specific times during a day in order to regain an adequate service level and hopefully contribute to improve service to the population.

Keywords: Logistics of health services, Relocation of ambulances, Re-optimization, Integer programming, System.

TH3_A

Modelling activity and costs of health emergency department

Enrico di Bella, Marcello Montefiori

Department of Economics and Quantitative methods, University of Genova, Italy
edibella@economia.unige.it, montefiori@unige.it

Italy is experiencing a Federalizing reform process which is driving the Country toward a decentralized provision and funding of local public services. The health care services are “fundamental” under the provisions of the law that in turn implies a standard cost for the financing of the system. The standard cost (as it is defined by the law) relies on the concepts of appropriateness and efficiency in the production of health care services, given a standard quality level. The control measurement of health care costs is a crucial task in the health economic evaluation and the system of standard costs simply aims at an average valuation of resource consumption. Various guidelines with different amount of details have been set up for costing methods in economic evaluation which, however, are defined in simplified frameworks and using fictious data. This paper is intended to examine the health related services provided by an Italian primary Regional Hospital analyzing real data referring to arrivals, waiting times, service times, severity (according to triage classification) of patients’ condition collected along the whole 2009. These data are matched up with all the relevant accounting and economic information concerning the cost faced by the Emergency Department. A new methodological approach is implemented in order to identify the standard production costs and its variability “between and within” the different types of patients. Procedures are herein expressed and used to identify clusters of patients homogenous in their characteristics.
At first the study provides a statistical analysis both of clinical and economic data. This is propaedeutic to the subsequent quantitative analysis and to the identification of a suitable methodology to cope with the problems of optimization involved. In the second part a theoretical model is suggested. The aim of the model

is to provide a better understanding of the phenomena at stake in the direction of an improvement in efficiency in the health care provision.
Our main objective consists, by a correct use of all the relevant information comprise in the medical and economic data, on providing and performing a sensitivity analysis via computer simulation to identify a new scenario that should curb operational cost in health care provision and boost quality/effectiveness of care. The data driven analysis is expected to produce results whose investigation should allow for an useful evaluation of the impacts of new operating strategies.

Keywords: resource allocation and standard cost in health care, statistical analysis and simulation, fiscal federalism and health care reform.

TH3_A

Relocating ambulances at the end of rescue missions

Vito Fragnelli[1], Stefano Gagliardo[2]

[1] *University of Eastern Piedmont, Italy*
vito.fragnelli@mfn.unipmn.it

[2] *University of Genova, Italy*
gagliardo@dima.unige.it

The standard approach of managing ambulances is based on the idea that each unit has an assigned location. Consequently, at the end of a mission the ambulance returns at its place; this approach may be improved allowing to relocate the unit in a more profitable way. In this case profitability refers to efficiency, i.e. look for satisfying the largest number of expected calls or to cover an area otherwise with scarce available ambulances. The method proposed by the authors, rooted in a game theoretic approach, allows giving a fast and efficient answer to the question of identifying one of the best location among the empty ones. The idea is to evaluate the expected calls, or other parameters like the area that may be covered by a unit according to the assigned location, referring to the Shapley value. The method could take into account the time required for reaching the candidate locations.

Keywords: Logistics of health services, Game theory, Regional system.

Epidemiology & Disease modelling (4)

TH3_B

A new approach for prevention and treatment of chronic diseases

Arjan Shahani

School of Mathematics and GeoData Institute, University of Southampton, UK
akshahani2@googlemail.com

Chronic diseases and conditions such as Arthritis, Alzheimer's, Asthma, Cancers, Diabetes, Depression, Hypertension, Multiple Sclerosis, Obesity, Parkinson's and Psoriasis are major health problems in many countries. This paper suggests that a new approach in which Western medical science and practices are combined with an Indian system of medicine called Ayurveda could be very effective for the prevention and treatment of many chronic diseases.

Western medicine uses scientific theories and clinical trials to evolve good treatments for particular diseases. Often these treatments involve high costs and side effects. Individual differences between people are generally not taken into account in the evaluation and use of Western medicine and advances in genetics may mean a better targeting of treatments. Prevention of many chronic conditions remains as a hope. A summary is that Western medicine is for treating diseases.
Ayurveda is medicine for health. The basic concept in Ayurveda is that a person has a particular mind-body constitution which is defined by three types of "energy". Balanced energies mean good health and particular imbalances can result in poor health and particular diseases. Ayurveda aims to detect and treat the "energy" imbalances. Ayurvedic medicine is commonly classified as: Internal Medicine, Surgery and treatment of head and neck, Surgery, Toxicology, Psychiatry, Paediatrics, Rejuvenation or anti-aging, Fertility. The government of India encourages the use of Ayurveda. Ayurveda is taught at many universities. There are a number of Ayurvedic research centres and there is a widely spread practice of Ayurveda.
There is a growing awareness of Ayurveda in many countries and combined Western medicine and Ayurveda could well be the medicine of the future. The modelling approach of Operational Research is a very promising instrument for evaluating Ayurveda and combinations of Western medicine and Ayurveda. This modelling approach will be illustrated through prevention and treatment of Diabetes.

Key words: Planning health services/care, Disease policy modelling, Simulation, Statistical analysis, Health providers, Patients.

TH3_B

Modelling feedback effects in the adherence of patients to medication

Martin Utley[1], Christina Pagel[1], Steve Gallivan[1], Nick Barber[2]

[1] *Clinical Operation Research Unit, University College London, UK*
m.utley@ucl.ac.uk

[2] *London School of Pharmacy, UK*

In the management of chronic disease, it is recognised that improved adherence to prescribed medication could deliver substantial health gains. However, patient adherence to prescribed medication is complex and interventions designed to improve adherence need to be informed by an understanding of this complexity. We have constructed a simple modelling framework with which to explore the potential consequences for this dynamic system of different assumptions concerning patient adherence in a range of contexts defined by different pharmacokinetic models. The role of feedback in determining system stability will be discussed.

Keywords: Adherence to medication, Stochastic modelling, Patient.

TH3_B

Modelling the Mental Health & Addictions "System" in Ontario, Canada

Sonia Vanderby, Michael Carter

Centre for Research in Healthcare Engineering (Department of Mechanical & Industrial Engineering), University of Toronto, Canada
{sonia, carter}@mie.utoronto.ca

To develop a 10-year strategy to address mental health and addictions (MH&A), the Ministry of Health and Long-Term Care (MOHLTC) of Ontario, Canada held numerous consultations with providers and consumers across the province. Through these discussions, feedback was obtained from individuals throughout the system with different experiences and perspectives and yielded a lengthy list of issues, areas of concern and proposed solutions. In an effort to focus the strategy on key areas of concern within this list, the MOHLTC wished to determine which aspects of the system would, if influenced by the strategy, have the greatest impact. This desire to identify "key levers" within the system led the MOHLTC to collaborate with the Centre for Research in Health Care Engineering (CRHE) to develop a system dynamics model of Ontario's existing MH&A system in an effort to adopt a systems perspective of mental health and draw together these numerous perspectives.

A literature review yielded no previous such efforts in the area of MH&A, hence an initial model was developed based on the consultation reports and other literature. The initial model was refined iteratively through three stakeholder workshops, held on January 14th, 23rd, and February 25th 2010, with final consensus on the model achieved in the third and final workshop. The final model was presented to the Minster's Advisory Group within the MOHLTC on March 10th, with full report delivered on March 19th, 2010.

Encompassing factors affecting the manageability of and changes in MH&A, the model was not limited to the treatment process or factors within the scope of the Ministry of Health and Long-Term Care, but extended to all aspects of the system, including aspects of finance, employment, social supports, relationships, providers and treatment. This model appears to be the first developed relating to mental health systems with such a scope.

Keywords: Health policy, System dynamics, System.

TH3_B

Evaluation of a composite System Dynamics, Discrete Event Simulation in a Sexual Health context

Joe Viana[1], Sally Brailsford[1], Paul Harper[2], Veerkathy Harindra[3]

[1] *School of Management, University of Southampton, UK*
{J.Viana, S.C.Brailsford}@soton.ac.uk

[2] *School of Mathematics, Cardiff University, UK*
harper@Cardiff.ac.uk

[3] *Department of GUM, St Mary's Hospital, UK*
veerakathy.harindra@porthosp.nhs.uk

Sexually Transmitted Infections (STIs) are a priority of many health services. *Chlamydia Trachomatis* (Chlamydia) is one of the most common STIs in the world. Chlamydia can have serious consequences for men and women in the form of infertility and particularly in women has been associated with Pelvic Inflammatory Disease (PID). Due to the consequences of Chlamydia various forms of screening are currently in operation throughout the world. A System Dynamics (SD) model of Chlamydia prevalence has been constructed to evaluate different screening strategies. The SD model incorporates risk groups, ageing, gender, heterosexual and homosexual relationships and migration in and out of the area of interest. A Discrete Event Simulation (DES) model has been constructed of the Genito-urinary Medicine (GUM) department at St Mary's Hospital, Portsmouth, the departments that treat patients presenting with STIs to enable healthcare professionals evaluate different GUM configuration, i.e. no. of treatment rooms, no. of staff, different opening hours and potential routes through GUM. A composite model has been developed in which the SD model provides the demand (number of patients) to be treated to the GUM DES model each month. The DES model transforms the demand generated by the SD model into patient probability arrival patterns based on historically recorded data. The DES model processes the demand based on its current configuration and provides the number of treated patients back to the SD model. The DES model and the SD

model can be run independently as stand alone models or in the composite state through a simple to user Excel User interface. Results from each model are presented and model development discussed. The simulation models were developed in close collaboration with healthcare professionals.

Keywords: Decision support system for health care, Disease policy modelling, Simulation, System dynamics, Health providers.

Home care

TH3_C

Integrated Vehicle Routing and Rostering for the Home Health Care Services

Zdeněk Bäumelt[1], Libor Waszniowski[1,2], Přemysl Šůcha[1], Zdeněk Hanzálek[1,2]

[1] *Department of Control Engineering, Faculty of Electrical Engineering*
Czech Technical University in Prague, Czech Republic
{baumezde, xwasznio, suchap, hanzalek}@fel.cvut.cz

[2] *Merica Ltd., Czech Republic*
{waszniowski, hanzalek}@merica.cz

This paper focuses on the personnel scheduling problem in the home health care services (HHCSP). The scheduled persons are nurses providing partly services to patients at home and partly in the hospital. The objective is to design routes of nurses that care about patients at home and to schedule shifts of nurses to provide sufficient workforce with respect to the subjective requirements on the schedule. Therefore, the HHCSP consists of two sub-problems, the vehicle routing problem with time windows and the nurse scheduling problem.
The routing part of the problem considers the time and the costs of travelling to patients. Each visit of the patient must occur at the defined time window, the total time of the route must be shorter than the length of the shift assigned to the nurse and all patients must be served. Moreover, a set of preferred nurses is assigned to each patient. The solution of the routing sub-problem minimizes the length of the routes, the cost for travelling time and the penalty for violation of the preferred nurse to patient assignment.
The solution of the scheduling part assigns one of three types of shifts (early, late and night) to nurses. The schedule satisfies hard constraints defined by the labour code, the collective agreement and the work regulations. The objective is to balance the total workload of the nurses and to balance travelling versus working in the hospital.
Due to the complexity of the HHCSP the both parts are solved by heuristic approaches. The patients' needs are taken into account as the input of the routing part. Consequently, the optimal routes are covered by the available nurses with respect to the scheduling part of the HHCSP. The paper shows how the both parts are integrated and evaluates the optimization algorithms on the set of benchmarks.

Keywords: Logistics of health services, Planning health services/care, Staff scheduling, Heuristics, Metaheuristics, Health providers.

TH3_C

Operations management in Home Health Care: Complexity factors and literature review

Emna Benzarti, Evren Sahin, Yves Dallery

Laboratoire Génie Industriel, Ecole Centrale Paris, France
{emna.benzarti, evren.sahin, yves.dallery}@ecp.fr

The Home Health Care (HHC) which represents an alternative to the traditional hospitalization can be defined as “the medical and paramedical care delivered to patients at their home. The care provided by HHC structures are comparable, in terms of nature and intensity, to the one that might be delivered to them within a traditional hospital.” HHC structures aim at maintaining or improving the clinical, psychological and social welfare of patients while containing operations related costs. However, despite the importance of this care structure’s type, the number of studies dealing with the organization of the care delivery within the HHC context is very modest. In this work, we develop a qualitative analysis identifying the complexity factors that the operations management domain has to face up within home health care structures characterized by the complexity and the heterogeneity of their activities. Then, we discuss how each complexity factor can affect the organization of the care delivery. The objective of this analysis is to develop innovative approaches adapted to the specificities of the home health care structures in order to better organize the delivery of care by improving the service quality while reducing the costs. Finally, we review the operations management models proposed in the literature within the home health care context. Based on this literature review, we point out that the existing models consider only a part of the complexity factors that we have previously identified. We also give an idea about issues, relevant from an organizational point of view, that have not been yet treated in the literature and thus represent unexplored opportunities for operations management researchers.

Keywords: Operations management of home health care services, Complexity factors, Benchmarking, Patients, Care providers.

TH3_C

An optimization tool for planning health home care services

Mario Lučić[1], Federico Malucelli[1], Maddalena Nonato[2], Alessandra Galletti[3], Caterina Montanari[3]

[1] *DEI, Politecnico di Milano, Italy*
mario.lucic@gmail.com, malucell@elet.polimi.it

[2] *Dipartimento di Ingegneria, Università di Ferrara, Italy*
maddalena.nonato@unife.it

[3] *ADI, Azienda Sanitaria Locale Ferrara, Italy*
{a.galletti, c.montanari}@ausl.fe.it

The practice of health home care for chronic patients and elder people is constantly growing. The main factors are the population aging and the perceived quality of life by patients being at home rather that at the hospital, but also the possibility of offering a high standard service at a low cost. For these reasons local health providers are putting more resources on this type of service. The service is usually managed manually coordinating the work of nurses moving in the territory and visiting patient homes providing the required cares. The main aspects to be considered are the so called fidelization, that is the preference of patients to be served by the same nurse, and the workload balancing among nurses. The increasing dimension of the service makes the managing problem very difficult to organize and calls for suitable optimization tools. We will present a software tool that combines a Geographical Information System with mathematical optimization models for the routing and the rostering of nurses. The case of the local health care provider of Ferrara will be presented.

Keywords: Planning home health care, Integer linear programming, Local health providers.

TH3_C

Application of Semi-Markov Processes in Modelling Patient Duration of Stay in a Home Care Service

Kian Seyed[1], Andrea Matta[2], Ettore Lanzarone[2], Mohsen Jafari[1]

[1] *Industrial & Systems Engineering Department, Rutgers University, USA*
kian_seyed@yahoo.com, jafari@rci.rutgers.edu

[2] *Dipartimento di Meccanica, Politecnico di Milano, Italy*
andrea.matta@polimi.it

Home care is the health or supportive care delivered to qualifying patients in their homes by healthcare professionals. The services are provided to patients with variety of health and social conditions (usually elderly people with complex conditions or terminally ill patients). Upon admission to a home care agency, patients are assessed and assigned to an initial care profile. In each care profile the number of visits and type of resources allocated to the patients vary. A patient may remain in the same care profile until discharge or may be assigned to a different one if his/her health or social conditions change. A patient's duration of care is comprised of the individual sojourn times in assigned care profiles and therefore, is a random variable with a general distribution. Having an estimate of this random variable can be greatly beneficial to the agency in terms of planning and allocating resources to new patients. The aim of this study is to develop a patient stochastic model to represent the transitioning of patients through different care profiles (states of the stochastic model) and then utilize it to predict patient duration of care using available historical data provided by the agency. This data was also used to determine the probability distributions of the sojourn times in the care profiles together with the transition probability matrix. The sojourn times may have any arbitrary distribution (semi-Markov modelling approach). Preliminary results indicate a quite good reproduction of the real data. Therefore, this modelling approach can be used as a practical decision support tool for the home care services.

Keywords: Home care service, Patient duration of care, Stochastic modelling, Semi-Markov processes, Provider.

Logistics (2)

TH4_A

Modelling Red Cell Inventory and Ordering Policies

John Blake, Matthew Hardy

Dalhousie University, Department of Industrial Engineering, Halifax, Nova Scotia, Canada
{john.blake, Matthew.Hardy}@dal.ca

Red cell transfusions are used to replace blood lost by patients due to surgery, trauma, or illness. A safe, reliable supply of red cells is necessary for the safe, efficient, and effective treatment of patients.
Red cells are collected from donors via a number of techniques, the most common of which involves separating the red cells from a whole blood donation. Red cells are stored at 4 ^{o}C and, since the 1970's, have been assumed to have a shelf life of 42 days. However, recent clinical studies have suggested decreased effectiveness or increased mortality amongst certain patient populations when older blood is used. Accordingly, blood system operators are evaluating the impact of shortening the regulatory shelf life of red cells from 42 days to perhaps 14 days.

In this talk, we present ongoing work to build models for evaluating the effects of a shortened red cell shelf life on blood system operators and consumer facilities. Our work is based on earlier work in platelets and seeks to find practical methods for minimizing blood shortages as well as outdates.

Keywords: Blood inventory and ordering, Analytical, Simulation, Dynamic programming, National system, Regional suppliers.

TH4_A

Optimal design of distribution networks: an application to the hospital drug distribution system.

Nicola Costantino[1], Mariagrazia Dotoli[2], Marco Falagario[1], Maria Pia Fanti[2], Agostino Marcello Mangini[2], Fabio Sciancalepore[1], Walter Ukovich[3]

[1] *Dipartimento di Ingegneria Meccanica e Gestionale, Politecnico di Bari, Italy*
{costantino, m.falagario, f.sciancalepore}@poliba.it

[2] *Dipartimento di Elettrotecnica ed Elettronica, Politecnico di Bari, Italy*
{dotoli, fanti, mangini}@deemail.poliba.it

[3] *Dipartimento di Elettrotecnica, Elettronica e Informatica, Università di Trieste, Italy*
ukovich@univ.trieste.it

A Distribution Chain (DC) is a supply chain that brings a set of final products (which do not undergo assembly or transformation processes) from producers to the final consumers. Recently, the research community has focused its attention on the pharmaceutical DC, because of the health care sector importance, both from the economical and social perspectives. On the other hand, in the pharmaceutical distribution network efficiency and effectiveness are imperative, since a failure in this sector has life and death implications that cannot be compensated in monetary terms.
The paper addresses the optimal design of the last branch of the pharmaceutical DC, i.e., the Hospital Drug Distribution Chain (HDDC), starting from suppliers till the local health units. To this aim, we consider a DC configuration strategy previously proposed by the authors and apply the approach to the HDDC design. More precisely, the recalled procedure employs digraph modelling and multi-objective mixed integer linear programming to design the network choosing among different Pareto-optimal problem solutions. In this paper we consider a distributed health care system composed of different stages connected by medicine and information links labelled with suitable performance indices and solve the HDDC configuration problem applying the recalled approach to the health care sector, talking into account such a DC distinctive features in the definition and evaluation of the chain performance. The optimization model is applied under structural constraints to a case study describing an Italian healthcare regional distribution chain and an optimal design configuration problem is solved for such a HDDC. A discussion on the advantages and limitations of the proposed technique is provided in the light of the health care DC flexibility and performance, as well as the straightforwardness for the HDDC manager.

Keywords: Planning health services/care, Performance measurement/evaluation in health care, Integer programming, System (Region & National).

TH4_A

Discrete-event simulation of donor flow in blood components collection

Alfonso Edgar, Xie Xiaolan, Augusto Vincent

Engineering and Health Division, École Nationale Supérieure des Mines de Saint-Étienne, France
{alfonso, xie, augusto}@emse.fr

Blood donation and transfusion service is an indispensable part of contemporary medicine and healthcare. Studies on blood donation in France made by CRéDOC (2007) and CERPHI (2006) funded by EFS (Etablissement Francais du Sang), show an increasing demand for blood products and the need for efficient management of blood collection systems, in order to increase the recruitment and maintain the retention of donors which is crucial in ensuring the supply of blood products. The present work presents a discrete-event simulation model based in the SIMAN language that represents the donors flow through the collection process of blood components in a region of France. This simulation model analyzes the donor service level and the performance of collection system under four key environmental elements: (i) collection of different blood components: whole blood, plasma obtained by plasmapheresis and platelets obtained by plateletpheresis, all with stochastic donation times, (ii) donor arrivals characterized by the combination of appointments scheduling with stochastic no shows and stochastic walk in donors, (iii) stochastic consultation times and deferrals and (iv) different staffing levels (doctors and nurses). This model evaluates the efficiency of collection system in terms of waiting times of donors and the total time required to donate (these times affecting donor retention), throughput rate of donors over the day, resources utilization, staff utilization, costs and service level. The simulation model is conceived as a potential tool to support the collection planning process and the donor appointment scheduling decisions; to identify strategies which lead to reduced donor wait-times and improved resources utilization.

Keywords: Blood donors flow management, Discrete-event simulation, Blood components collection system

TH4_A

A Memetic algorithm for the design of hospital material flows

Yannick Kergosien, Christophe Lenté, Jean-Charles Billaut

Laboratoire informatique de Tours, Université François Rabelais Tours, France
{yannick.kergosien, christophe.lente, jean-charles.billaut}@univ-tours.fr

The Hospital Centre of Tours (France) is reorganizing the logistic services between its hospital units, located at different places in the city. Each hospital unit has to be supplied with clean linen, meal carts, medicines, sterile equipments for operating theaters, medical patient records, and other various equipments. In addition, dirty linen and waste have to be collected from each unit. The Hospital Centre also plans the creation of an independent team of warehouse persons for the largest unit of the complex. Thanks to this team, vehicles will load and unload only at one dock, facilitating the traffic within the hospital. The team will help load and unload carts and will mainly support the delivery and pickup at the buildings of the units possibly using tow tractors and underpass. The whole problem can be seen as a two-level pickup and delivery problem with time windows, where two vehicle routing problems interact. The design of this team (composition and planning) is strongly related to the routes of the vehicles between the hospital units.
To solve this two-level pickup and delivery problem, we propose a Memetic Algorithm, using a genetic algorithm and a tabu search. Our objective is to plan the routing and to size the teams (drivers and warehouse persons). The evaluation of a solution is a linear combination of two criteria: the sum of lateness to deliver or

pickup demands, the estimated number of warehouse persons and drivers needed to perform all routes. Considering a single day, the problem is NP-hard and is called "The fixed job schedule problem with spread-time constraint". But, we also consider the constraint of maximum working hours per person including the break, and the problem has to be solved for a five day period so that each person has the same timetable each day.

Keywords: Logistics of health services, Metaheuristics, Logistics between hospital units.

Planning health services (4)

TH4_B

Improving the medical records processes at Ayatolah Kashani Hospital in Isfahan, Iran by lean management

Sima Ajami[1], Saeedeh Ketabi[2], Sakine Saghaeinnejad Isfahani[3], Akram Sadeghian[4]

[1] *Medical Records Department or Health Management & Economics Research Centre, Faculty of Medical Management & Information Sciences, Isfahan University of Medical Sciences, Isfahan, Iran*
Ajami@mng.mui.ac.ir

[2]*Department of Management, Faculty of Administrative Sciences and Economics, University of Isfahan. Isfahan, Iran*
sketabi@yahoo.com

[3]*Medical Records Department, Faculty of Medical Management & Information Sciences, Isfahan University of Medical Sciences, Isfahan, Iran*
saghaeiannejad@mng.mui.ac.ir

[4]*Medical Records Department or Health Management & Economics Research Centre, Faculty of Medical Management & Information Sciences, Isfahan University of Medical Sciences, Isfahan, Iran*
sadeghian_akram@yahoo.com

Background: The Medical Records ward supplies basic information in health systems. This information provides value field in research and training in health sciences. Therefore, Medical Records manager and personnel should use of scientific techniques for improving the quality of services. Lean management is a method of improving which identifies and eliminates wastes ways based on identified customer requirements. The aim of this research was improving the Medical Records processes at Ayatollah Kashani Hospital in Isfahan by lean management.
Methods: This study is cross-sectional in which data has been collected by brainstorm, observations, interview and review of documents. Population includes Medical Records staff and other stakeholders this ward in hospital that are contact with Medical Records department and customers of this department. At first meeting, staff of Medical Records has been learned concept of lean management then formed lean management team. In the many meetings, lean management team reviewed current process of this ward. Then, lean management team has identified wastes, values and proposed idea to improve this process.
Findings: Results shows that 17 current processes are in four sections (filling, coding, statistic and admission) in Medical Records ward. In four sections (filling, coding, statistic and admission) have been identified 28 wastes and 11 values. Those 27 comments have been offered for delete these wastes. At last lean management team have been modified eight current processes.
Conclusion: Medical Records ward is vital department for health systems. Therefore, using of scientific methods in managing this department is necessary. Lean management is method that deletes waste and improves quality of services and increase satisfactory of customers.

Key Words: Medical Records ward, Improving, Lean Management, Process Improvement.

TH4_B

Integration of medical decisions into an Intensive Care Unit simulation model

Cristina Azcárate, Fermín Mallor

Department of Statistics and Operations Research, Public University of Navarre, Spain
{cazcarate, mallor}@unavarra.es

In this paper we show, through a validation process of an Intensive Care Unit (ICU) simulation model, that the inclusion of medical decisions is crucial to get an accurate representation of the system. The validation process demonstrated that the length of stay of some patients can be influenced by the ICU bed occupancy level. This finding was confirmed by the ICU medical staff, who reported that some of their decisions depend on the number of occupied beds. Specifically, doctors may allow earlier patient discharge when the number of occupied beds is so high as to compromise the medical care of new incoming patients. Conversely, when the ICU workload is low, patients are allowed to extend their stay to ensure a more complete recovery. However, there is no written protocol or structured methodology to make these decisions. Because of the importance of including these decisions, medical staff wrote down a list of general principles of common application which reflected the dependence of these decisions not only on the bed occupancy level but also on the flow of patients from the surgery theatres (ST), especially those scheduled in advance.
In order to get a valid ICU simulation model we have extended it by including new facilities: the ST and its associated post-anaesthesia recovery room. Thus, in addition to the ICU input modelling, it is necessary to reflect the scheduled input to the ST as well as the different paths followed by patients among all facilities considered and the length of stay in each one of them. Furthermore, the general management principles are also represented.
This methodology is applied to the simulation of the ICU of the Hospital of Navarre, which is the reference health centre for the city population of over 200 thousand, and also a complementary centre for the whole Navarre.

Keywords: Planning health services/care, Simulation, Statistical analysis, Health providers.

TH4_B

Clinical wards and the impact of elective admissions

René Bekker[1], Paulien Out[1,2]

[1] *Dept. of Mathematic, VU University Amsterdam, The Netherlands*
rbekker@few.vu.nl

[2] *CC Zorgadviseurs, The Netherlands*
p.out@cczorgadviseurs.nl

With the growing demand for health care resources, the pressure on the efficient usage of the available bed capacity is increasing. The variability in workload at clinical wards however requires a rational overcapacity to respond to peaks in demand for beds. For an efficient capacity usage it is desirable to reduce such workload variations. Surprisingly, studies have shown that the variation in the number of admitted scheduled patients is generally at least as large as the variation in the number of emergency admissions. The variability in admission pattern leads to highly variable bed occupancy. Moreover, during the weekend the number of elective admissions is generally very small leading to extra workload fluctuations over the week.

The aim of this paper is to analyze the impact of admission patterns on the variability in bed occupancy and the number of refused admissions in clinical wards. More specifically, we consider (i) the impact of reducing the daily variability in admissions, (ii) the impact of a structural weekly admission pattern in which there are no elective admissions during the weekend, and (iii) an optimal admission schedule for elective patients such that a desired daily occupancy is achieved. In practice, the results can be implemented by providing admission quota prescribing the target number of admissions for each patient group.
Currently, the Erlang loss model is often used to determine the required number of beds in clinical wards. This model is a natural candidate as the arrival process of (elective) patients can often well be approximated by a Poisson process. For (i), we use a heavy-traffic limit theorem for the G/G/infty queue yielding an intuitively appealing approximation in case the arrival process is not Poisson. This is highly relevant to show the merits of reduced variability in the number of elective admissions.
Regarding (ii), we assume a time-dependent weekly admissions pattern. Using a time-dependent analysis, we determine the mean offered load per day. This performance analysis is the basis for finding an optimal admission schedule in (iii). Given a target average occupancy per day, we use the time-dependent analysis in combination with a Quadratic Programming model to determine the optimal number of elective admissions per day, such that the difference between the target and realized load is minimized. From the mathematical results, practical scenarios and guidelines are derived that can be used by hospital managers and support the method of quota scheduling.

Keywords: Admission planning for clinical wards, Resource allocation in health care, Queuing theory, Quadratic programming, Health providers.

TH4_B

Design and Optimization of a Hospital Inpatient Bed Management System

Jonathan E. Helm, Mark P. Van Oyen

Industrial and Operations Engineering Department, University of Michigan, USA
{jhelm, vanoyen}@umich.edu

A hospital is not a single entity, but rather a complex network of subsystems that must all work together in synergy to serve each patient's dynamically changing care needs. In many hospitals, these subsystems function autonomously with relatively little visibility into the effect of their policies on other subsystems of the organization. An improvement initiative in one subsystem can often be detrimental to another. This uncoordinated manner of hospital management has been shown cause excess costs, elective cancelations, emergency blockages, emergency department congestion and even mortalities. This talk presents a framework for coordinating critical hospital subsystems through effective management practices that optimize system metrics for the hospital system as a whole. The focus is on effective policies to manage the flow of inpatients into the hospital while considering the effect of such admissions on the downstream network of bed units/wards.
To coordinate and stabilize the hospital subsystems we develop stochastic models of hospital census to predict system-wide patient flow. These models are built from stochastic patient care pathways that can be described by a temporal resource requirements matrix – a matrix that details the probability that a patient will require a particular resource bundle (e.g. a certain type of bed) at a given point in their treatment. Combining these modules one can describe the overall stochastic process that governs the resources required to serve a population of patients. By analyzing this stochastic process one can design policies that maintain a high utilization of hospital resources while mitigating the incidents of congestion, cancelation, and overflow. In the talk, a hospital inpatient bed management system based on this modelling approach will be presented, along with methods for optimizing the system's control parameters according to system level metrics. The

optimized management system will be compared to current practice, demonstrating significant improvements in system functioning.

Keywords: Decision support systems for hospital bed management, Stochastic models, Patient flow modelling and simulation, Policy optimization, Health provider and patient, Enterprise level (hospital).

Patient flow (3)

F1_A

Integral multidisciplinary rehabilitation treatment planning

Aleida Braaksma[1,3], Nikky Kortbeek[2,1], Gerhard Post[3], Kees Bijl[4]

[1] *Department of Quality and Process Innovation – Patient Oriented Logistics, Academic Medical Center Amsterdam, The Netherlands*
A.Braaksma@amc.nl

[2] *Department of Applied Mathematics – Stochastic Operations Research, University of Twente, The Netherlands*
N.Kortbeek@utwente.nl

[3] *Department of Applied Mathematics – Discrete Mathematics and Mathematical Programming, University of Twente, The Netherlands*
G.F.Post@utwente.nl

[4] *Department of Rehabilitation, Academic Medical Center Amsterdam, The Netherlands*
C.J.Bijl@amc.nl

At a rehabilitation outpatient clinic patients are treated to recover from injury, illness, or disease to as normal a condition as possible. To achieve this, patients require a series of treatments by therapists from various disciplines. At the start of the rehabilitation process a patient visits a rehabilitation physician, who designs the treatment plan. The treatment plan prescribes the disciplines the patient should be treated by, the number of appointments per discipline and the week in which each appointment should take place. In current practice, when treatments are planned, a lack of coordination between the different disciplines, and the deficiency to plan the entire treatment plan at once, is often witnessed. This jeopardizes both quality of care and logistical performance.

Our integral treatment planning algorithm, that plans the entire treatment plan at once, ensures continuity of the rehabilitation process, while simultaneously controlling other performance indicators such as access times, utilization and combination-appointments. Upon a planning request multiple planning proposals are generated by an integer linear program (ILP), based upon the treatment plan and the availability in centrally controlled therapist schedules. From these proposals, the one that is preferred by the patient is actually planned. The ILP incorporates that therapist idleness is prevented, combination appointments are encouraged and appointments in consecutive weeks have equal starting timeslots. We evaluate our approach by computer simulation.

We apply our approach to a case study within the rehabilitation outpatient clinic of the Academic Medical Centre Amsterdam. Until recently treatment plans for the individual patient were not formally recorded. Based on information from hospital databases we constructed seven different treatment plan blueprints. We evaluate our approach for a group of patients who follow the seven hypothetical treatment plans. Applying our approach to this case shows promising results.

Keywords: Rehabilitation treatment planning, Planning health services/care, Patient flow management, Integer linear programming, Simulation, Patients, Health provider.

F1_A

Feasibility of walk-in: a case study of CT-scanners

Erwin W. Hans[1], Nikky Kortbeek[2], Jasper R. Van Sambeek, Jelmer Kranenburg

[1] *Center for Healthcare Operations Improvement and Research (CHOIR), University of Twente, The Netherlands*
e.w.hans@utwente.nl

[2] *Center for Healthcare Operations Improvement and Research (CHOIR), University of Twente, The Netherlands*
Academic Medical Center (AMC) Amsterdam, The Netherlands
n.kortbeek@utwente.nl

Introduction. We study the CT scan modality of Academic Medical Center in Amsterdam. Earlier research in this hospital has shown that patients prefer short access times and multiple same-day appointments over short waiting times. Our goal is to investigate the logistical feasibility of various degrees of walk-in. Walk-in contributes to a higher patient service as access time is completely eliminated.
Approach. CT-scanners have a non-stationary arrival pattern as demand fluctuates within and between days. We investigate how to counteract the non-stationary demand by scheduling appointments during periods of low expected demand. We explore several interventions in which the degree of walk-in is varied, and an intervention where inpatients are called in from the ward at times the expected waiting time is low. Patient data was acquired over the year 2008 and time-stamp measurements were performed. A discrete-event simulation model was developed to explore the logistical performance of each intervention. This research took place in close cooperation with the radiology department of AMC, as well as Alysis in Arnhem.
Conclusions. Walk-in is not feasible for all patients, as some examinations require the presence of other medical specialists, because large preparation times are required, or simply because some patients will prefer to make an appointment. We demonstrate that walk-in combined with appointments significantly improves patient service. Patients can combine multiple appointments on the same day, and planned patients can achieve lower access times. Calling in inpatients from the ward during times of low expected waiting time reduces the number of rejections and number of patients that decide to leave because of high expected waiting times. In addition, we have shown that by introducing walk-in, the CT department is able to serve more patients under the same capacity, indicating a higher attainable efficiency.

Keywords: Patient flow management, Simulation, Health provider (hospital).

F1_A

The feasibility of walk-in: a formal analysis

Nikky Kortbeek[1,2], Maartje Zonderland[3,1], Richard Boucherie[1], Nelly Litvak[1]

[1] *Department of Applied Mathematics – Stochastic Operations Research, University of Twente, The Netherlands*
n.kortbeek@utwente.nl

[2] *Department of Quality and Process Innovation – Patient Oriented Logistics, Academic Medical Center Amsterdam, The Netherlands*

[3] *Division I, Leiden University Medical Center, Leiden, The Netherlands*

Outpatient clinics and diagnostic testing facilities traditionally provide patients with individual appointments to balance workload. Disadvantages however, include patients needing to revisit the hospital, an involved planning process and potentially long access times. To improve accessibility, increase the freedom of patients to choose the moment of their hospital visit, or to allow the patient to visit several care providers on a single day, an increasing number of outpatient clinics facilitate walk-in service. The drawback of walk-in service is that some patients cannot walk in, because they require preparation activities before their treatment

or consultation can take place. Furthermore, the arrival process of walk-in patients can be highly stochastic, which can result in long waiting times or low utilization. In this study we explore the viability of various walk-in based policies, in which both appointments and walk-ins are facilitated. We present a stochastic method that finds the mixed strategy that finds an optimal balance between the benefits and drawbacks of the pure appointment and walk-in policies.
Appointments that are inevitable are preferably planned when the expected walk-in demand is low. To further smooth fluctuations in periods of high demand, the clinic can also offer walk-in patients an appointment on a later date. To exploit these ideas, and effectively counterbalance the non-stationarity of walk-ins at both the daily and cyclic (i.e. weekly, biweekly or monthly) level, we look for a cyclic appointment schedule, which specifies the maximum number of patient allowed to plan on each specific day and time in the cycle.
To find an adequate cyclic appointment schedule, we decompose the problem. First, the capacity cycle is determined, which prescribes the number of jobs that can be scheduled each day. Then, the day planning is specified. Since a good strategy balances the opportunities for walk-in patients to be served on the same day without excessive waiting and for appointment patients to be served within a reasonable number of days, we try to find the cyclic appointment schedule where the fraction of walk-in patients served on the day of arrival is maximized, while the access time service level for appointment patients attains a pre-specified norm.

Keywords: Outpatient clinics access policy, Planning health services/care, Resource allocation in health care, Open access, Queuing theory, Markov reward processes, Heuristics, Patient, Health providers (Unit & Hospital).

F1_A

Developing a patient-flow supply chain reference model to enhance performance management in healthcare

Kristian Rotaru, Andrzej Ceglowski, Kim Langfield-Smith

Department of Accounting and Finance, Monash University, Australia
{Kristian.Rotaru, Andrzej.Ceglowski, Kim.Langfield-Smith}@buseco.monash.edu.au

Commonwealth health spending in Australia is projected to rise from 4.0% of GDP in 2001-02 to 8.1% in 2041-42. This will lead to government expenditure exceeding the amount raised in taxes by 5% of GDP by 2041-42. This trend requires a greater focus on the performance improvement of healthcare operations. The existing applications of supply chain management principles to healthcare aim at enhancing effectiveness and efficiency of healthcare operations, dealing mostly with the efficient and cost-effective supply of goods (such as medical supplies and consumables) to health organisations.
This paper adopts a patient-centred perspective to supply chain management in healthcare. Taking into consideration that patients cannot be treated like products, are not identical units, have preferences and cannot be warehoused, it is impossible to directly apply existing supply chain concepts to improve the performance of patient-flows. To address this theoretical and practical issue, the paper conceptualises the process of adapting a cross-industry supply chain reference model, namely the Supply Chain Operations Reference (SCOR) model, to the context of healthcare operations. While SCOR provides a framework for performance management, its application to healthcare involves considerable adjustments to account for the existence of patients as the "unit" of operations, the complexity of the flows, and the resulting need for tailored performance indicators. SCOR integrates properties of business process engineering, benchmarking and best practices analysis into a single process reference model. The paper leverages off these four SCOR characteristics by focusing on the operational level of patient-flow processes to improve patient-flow supply chains. This paper reports on the results of this ongoing process and suggests a research framework and a set of guidelines for designing a patient-flow reference model based on SCOR.

Therefore it presents the first steps in adapting the SCOR model components to the context of healthcare operations.

Keywords: Patient flow management, Conceptual modelling, Benchmarking, System.

F1_A

A framework for the analysis of hospital patient flows: the results of an Italian benchmarking study

Stefano Villa[1], Giuliana Bensa[2], Isabella Giusepi[2], Anna Prenestini[2]

[1] *CERGAS (Centre for Research on Health and Social Care Management), Bocconi University, Italy*
Healthcare Operations Management Unit, Catholic University, Roma, Italy
stefano.villa@unibocconi.it

[2] *CERGAS (Centre for Research on Health and Social Care Management), Bocconi University, Italy*

In the recent literature several studies have presented and analyzed a series of models, and managerial and technical solutions to better support patient flows management focusing specifically on single production units such as operating room, emergency department, radiology and so on. However, few studies have suggested a thorough, system-wide and solid methodology to help hospitals in the diagnosis of their own specific patient flows problems, an essential starting point to carry out effective patient flows improvement strategies.
With the present contribution we intend to provide a four-steps methodology to assess hospital patient flows problems.
The findings presented are the results of a cross-sectional study that has involved eleven different hospitals that have shared, with the research team, all their data in order to understand the causes of their problems and perform a benchmarking analysis.
The methodology developed to asses hospital patient flow problems is developed around four different levels:

1. Hospital-wide system
   The study compares the eleven hospitals along a series of standard indicators such as beds occupancy rate, number of beds turns, percentage of emergency cases and average length of stay.
2. Hospital pipelines
   We identified five different physical pathways (that we called pipelines): 1. emergency patients; 2. surgical patients; 3. medical patients; 4. day-surgery and 5. outpatient.
3. Production lines
   Each hospital pipeline is then characterized by a different mix of clinical macro processes that we have called production lines.
4. Production Units
   As final step of the analysis, we analyzed the capacity utilization patterns of the different production units involved with a particular focus on the analysis of the horizontal interdependencies.

The results of the benchmarking study have outlined, among other things, two important issues:

- hospitals are characterized by a quite large component of patient flows' artificial variability, that is often the cause of typical hospital operational problems.
- the source of this variability is often far from the area where problems are actually recorded.

Keywords: Patient flows management, Benchmarking, Hospitals, Variability.

Quality

F1_B

An inconvenient truth: bias in qualitative variables for OR modeling

Luc Delesie[1], Marc Haspeslagh[2], Kristof Eeckloo[1]

[1] *Center for Health Services Research, Catholic University of Leuven, Belgium*
{luc.delesie, kristof.eeckloo}@med.kuleuven.be

[2] *az sint jan brugge-oostende av, Bruges, Belgium*
marc@haspeslagh.net

Many fancy OR models fade out after publication in scholarly journals. One cause is that real-life users back away from the assumptions and simplifications of their construed variables. Examples are physician performance, patient satisfaction, competence assessment. These variables, called qualitative, essentially rely on opinion: public and/or expert opinions solicited in questionnaires with a limited number of questions and response categories. Numeric assumptions and plain averaging are common: the power of convention. But this approach that assumes large 'average' populations hardly convinces actual decision-makers who usually deal with much more messy situations and real-life nuances in small-scale settings. All opinions are individual and subjective and carry non-negligible so-called bias.
This contribution shows what opinion measurement implies. An experiment where nurses on different units assess the aptitude of themselves and their colleagues to improve patient-nurse allocation with a view to better depression care outcome allows investigating this opinion measurement and inherent bias. This contribution explains the different types of opinion bias by way of examples from the data. It defines the prerequisite conditions and illustrates the refinement necessary to arrive at scores that respect more appropriately the relevant relationships in the questionnaire data than the conventional numeric assumptions and sums or averages. A next part indicates how and to what extent the particular experiment allows evaluating these different types of bias in nurse opinions. The main part develops a method to deal with these and exemplifies the different technical steps. This method results in calibrated nurse aptitude scores within each unit and between units. The final part discusses the validity of the method in comparison to the conventional numeric assumption and averaging procedures and modern test theory such as item response theory-IRT.

Keywords: Aptitude assessment, Rank order statistics and algorithms, More valid and reliable qualitative scores.

F1_B

The assessment of hospital staff satisfaction

Alberto Franci [1], Caterina Gurrieri [2], Mario Corsi[1]

[1] *University of Urbino "Carlo Bo", Italy*
{alberto.franci, mario.corsi}@uniurb.it

[2] *University of Urbino "Carlo Bo", Italy*
c.gurrieri@hotmail.it

The new N.H.S. reform in Italy acknowledges that the success of the hospital service depends on the excellence of its staff and on the satisfaction of its patients. While many hospitals have access to detailed patients' satisfaction information, significantly less information is available on the experience of hospital staff. To this aim, our University Research Centre undertook a survey inviting staff to express their views

about their job satisfaction in three hospitals of the Marches Region (Italy). The response rate was high, higher than ever achieved in other Italian hospitals. This research presents a summary of the quantitative results in narrative and table format. It also gives a contribution to the knowledge about hospital staff satisfaction methodology.

Keywords: Performance measurement/evaluation in health care, Statistical analysis, Health providers.

F1_B

Job satisfaction among social workers in the Marches Region in Italy

Alberto Franci [1], Caterina Gurrieri [2], Mario Corsi[1], Greta Brardinoni[3]

[1] *University of Urbino "Carlo Bo", Italy*
{alberto.franci, mario.corsi}@uniurb.it

[2] *University of Urbino "Carlo Bo", Italy*
c.gurrieri@hotmail.it

[3] *University of Urbino "Carlo Bo", Italy*
gretabrardi@yahoo.com

The study represents an evaluation of job satisfaction among professional social workers of the Marches Region (Italy). We used a self-administered questionnaire mailed to 1084 subjects, obtaining a response rate of 58.4%. The analysis of satisfaction levels has shown a strong variability among the different items. The comparison between the different professional categories has generally highlighted higher levels of satisfaction among operators working within the National Health Services compared to those working within Municipal Agency. The search for overall satisfaction predictors has been carried out using the classification trees technique. Among NHS employees the main determinants are: *working autonomy*, *perception that families have of social workers' action, skills improvement* and *exchange of information with colleagues*. While for Municipal Agency the best determinants are: *skills improvement*, *recognition received from superiors*, *professional challenges* and *help received from colleagues*. Finally, the Priority Index has highlighted those items which will need corrective actions.

Keywords: Job satisfaction, Classification trees, Priority index.

F1_B

The Patient needs and the answer General Practitioner: the Italian citizens experience.

Cinzia Panero[1], Anna Maria Murante[1], Giovanni Perucca[2]

[1] *Laboratorio Management e Sanità, Scuola Superiore Sant'Anna, Pisa, Italy*
{c.panero, a.murante}@sssup.it

[2] *Dipartimento di Scienze Economiche e Finanzirie "G.Prato", University of Torino, Italy*
Department of Economics, Business and Statistics, University of Milano, Italy
giovanni.perucca@unimi.it

Background. In the last years the interest for patient experience with health care services largely increased. Several surveys have been conducted in order to observe if health care systems answer to the overall patient needs. In 2000 World Health Organization challenged modern health care providers to ensure responsiveness

to patients, i.e. to deliver also non-health assistance (respect for dignity, confidentiality, prompt attention, quality of amenities, access to social support networks, choice of provider, etc.).
Aim. To investigate patient experience with General Practitioner assistance and to measure the impact of personal and organizational characteristics on overall satisfaction and on willingness to recommend. Poor evidence is available in Italy about connections between perceived quality and the capability of the healthcare system to respond to patients' needs.
Method. In 2009 a sample survey was conducted in four regions of Italy (Toscana, Piemonte, Umbria, Liguria). About 15.000 citizens answered to a large questionnaire related to Primary care services, including a section dedicated to General Practitioner (GP) assistance. A logistic regression model was applied to analyze which are the predictors of overall satisfaction with GP, focusing mainly on variable related to patient's expectations, continuity of care and organizational aspects (e.g. scheduled access, waiting time, health case history, etc.), and if there are differences among the four Italian Regions monitored.
Results and Conclusion. The inhabitants of the four Italian Regions refer a nice experience with GP assistance: more than 85% of them judged excellent or good the overall service. Generally, in some regions patient expectations affect more the willingness to suggest GP to friends or family members than the judgement on service. Besides the findings provide convincing evidence that GP is a nodal point in the continuity of care process.

Keywords: Health system responsiveness, Regression model, Patient's expectations, Continuity of care and organizational aspects as predictors of overall satisfaction with GP.

F1_B

Applying Problem Structuring Methods to Patient Safety Research: a case study of the implementation of the Patient Safety First Campaign

David E. Puga-Bolio

Department of Management Science, Lancaster University Management School, UK
d.puga-bolio@lancaster.ac.uk

As a result of a growing concern about the quality of health care services research into patient safety-related issues has grown exponentially in the past decade and even though leading voices in the field advocate for a 'systems-approach' to patient safety, the use of formal Operational Research techniques and problem structuring methods in the field of patient safety remains limited.
As part of a pilot study looking into the factors affecting the implementation of the Patient Safety First campaign in an acute general hospital in England, an approach combining elements of qualitative analysis methodologies and problem structuring methods, with an emphasis on soft systems methodology was used to describe and analyse perceived problematic situations encountered during the process as well as to construct a model of the organisation's patient safety system, with the idea of promoting discussion among the different actors and stakeholders of the process and to eventually reach an understanding of patient safety viewed as a purposeful system of its own rather than merely a property emerging from the greater healthcare system. While PSMs can produce a model with the intent to understand and clarify a problematic situation by incorporating different perspectives, it is the iterative process of searching for information and disseminating that information among all those involved that produces a positive result.
As a result of the analysis of information obtained from a series of interviews, observations and discussions with staff involved in the implementation of the actions of the campaign, a model was built where the importance and influence of several elements in the system were highlighted, and actions directed towards setting up a system where the development of a safety culture within the organisation were proposed, as well as explicit measuring and monitoring processes.

Keywords: Patient Safety Implementation/Management, Problem Structuring Methods, Soft Operational Research, Health providers.

Software and Projects

F1_C

Private Public partnership: An experience sharing of Blue Star Social franchising program

Salah Uddin Ahmed

Social Marketing Company (SMC), Bangladesh
su.ahmed@smc-bd.org

SMC's Blue Star Program began in June 1998 as a pilot with the purpose to address the unmet need of the target population by improving quality, awareness, accessibility and affordability of priority public health services through the private health providers. The program initially started with Graduate Doctor . Since the year 2000 it was expanded to include non-graduate providers as well. Initially the Blue Star Providers (BSPs) provided SOMA-JECT, SMC's over branded Injectable contraceptive. Gradually other public health services are included in the program through these BSPs. SMC provides comprehensive training, commodity supply, promotional support, supervision & monitoring of these BSPs.
The services offered through Blue Star program are:

- Family Planning (FP) counseling and Injectable administration(SOMA-JECT)
- IntraUterine Device services (selected BSPs)
- Maternal and neonatal health care (selected BSPs)
- Tuberculosis (TB) identification and referral

During the period (Feb '06- Apr'09), 164 GDs and 3053 NGMPs were providing service under Blue Star Program.The Blue Star providers play a vital role specially in implementing clinical contraceptive particulary Injcetable and they contribute twenty percent of National Contraceptive prevalence rate. The challenge is to sustain the providers interest including quality of care.

F1_C

Development of a Personalized Health Decision Support System

Georghe Bacioiu, Zbigniew J. Pasek

Industrial and Manufacturing Systems Engineering Dept., University of Windsor, Canada
{bacioiug, zjpasek}@uwindsor.ca

Canadian healthcare sector is the second largest employer with close to 2 million employees, surpassed only by the trades' category. Also, healthcare is one of the three industries (others are educational and government) that has expected growth in the coming years. The development of in-home medical technologies, substantial cost savings, and patients' preference for care in the home have helped change this once-small segment of the industry into one of the fastest growing healthcare services.
This paper will focus on a concept of Personalized Health Decision Support System (PHDSS) as a key part of the generally defined home healthcare (HH) system. PHDSS enables the individuals to take ownership of their own health by properly managing the health risks they are willing to take. That includes self-performing most – if not all - of the activities related to their health with minimal engagement of health care professionals. In essence, the individuals will become decision makers in their own case with the help of a decision support tool. The vision of this research is to create a self-care system that, in the majority of the cases, will not require substantial interaction with professional health care providers.
The paper explores the field of medical technologies that can effectively support the PHDSS concept. A methodology allowing seamless integration of necessary components, personalization of solutions, as well as design of the interfaces with other systems will be based on Advanced System Design concepts. An

Evidence Based Practice based on Advanced Statistical Analysis will be applied to facilitate the patients' access and effective use of the latest medical research, as well as assist in the remote monitoring by the healthcare professionals. The Organizational Theory will be used to understand what organizational design (in a broad sense) would best fit the evolving PHDSS model.

Keywords: Decision support systems for health care, System design combined with evidence-based practice, Patient.

F1_C

TeamFocus: Community Mental Health Services

Steven J. Burnell

Focused_On Ltd, UK
SJBurnell@Focused-On.com

Someone once said that Teams are like Italian sports cars – they are powerful but very expensive and you must keep all of the parts in tune if you want to enjoy outstanding performance.
In Healthcare, however, Teams are not a luxury – they are the only viable way of delivering effective Services.
In Healthcare, we see massive investment in Teams. Some of the biggest are trying to keep people out of hospital by delivering Mental Health Services in the Community.
TeamFocus is a new simulation model designed to help Leaders to tune their multi-disciplinary Teams including Clinicians, Support, and Social Workers.
A region might have ten Teams, each providing Functions such as Psychiatry, Social Work, and Care Co-ordination. Some Teams will focus on Adults whilst others will focus on Older People.
A Census will normally focus attention on which of the 21 Clusters of Care the Teams ought [not] to be serving. Then, the Staff Resources in each Team will specify which Function(s) they can deliver and each Team will specify which Patient Criteria they can accept.
Together, they specify how much effort (how many Care Points) they need to commit to each Patient and Patients have statistically variable Lengths of Stay in three Phases of Treatment (Red/ Amber/ Green). And, some Patients will require multiple Episodes of Treatment and some will Transition between Care Clusters (e.g. to/from Psychotic Crisis).
The model can be set to automatically assign Most Economic Resources and you can measure and eliminate the use of 'Bank' Resources.
The goal, therefore, is to establish which Clusters of Care need to be delivered by this Service (some Patients ought to be served elsewhere), and to optimise the Teams, Staff Resources, and Functions required to provide a prompt and sustainable Service that the Health Economy can afford.

Keywords: Large expensive multi-disciplinary teams, Discrete event simulation modelling, Providers & commissioners of social & healthcare services.

F1_C

SurgiQ, waiting list management made easy

Barbara Canesi[1,2], Luca Corradi[1,2], Ornella Mazzetti[3], Ivan Porro[1,2], Nicola Rosso[3]

[1] *Biolab (DIST), University of Genova, Italy*
barbara.canesi@dist.unige.it

[2] *Nextage Srl, Genova, Italy*
barbara.canesi@nextage-on.com

[3] *SIET, Galliera Hospital, Genova, Italy*
nicola.rosso@galliera.it

The problem of managing elective waiting lists is one of the most relevant issue in modern public healthcare systems. Organizations have to deal with many constraints, especially in the public welfare. Therefore, a novel approach has been experimented during two research projects (2001-2007) aimed at introducing and validating the Surgical Waiting List Info System (SWALIS) model into a clinical research context. Such a model is based on the assignment of an implicit urgency score given to each patient at registration into the waiting list, according to Italian regulation established by the national Government. SWALIS allows to order dynamically the registrations on the list and to guarantee equity and to improve the respect of waiting time.
Galliera Hospital (Genova, Italy), in 2008, established to adopt this model. Since the innovation of the process SWALIS is based on needed to be realized into an industry proven product, the work has been carried out by Nextage, a newly founded start-up from the University of Genova. The developed product, named surgiQ, offers waiting lists management tools as a Web based application. Designed and deployed in cooperation with clinicians from Galliera Hospital, it also collects data that can be used to optimize the whole process, resulting in both reduced waiting time and list length. Moreover, some satisfaction markers for operators and patients can be studied with several statistical methods. SurgiQ simplifies the management of all registrations by having the whole list accessible at a glance to operators and includes information for patients and monitoring of their waiting time. Several reports (e.g. waiting list dynamics) and tools (resources planning) are provided both for surgeons and managers. SurgiQ has been firstly applied to the vascular surgery division and it is going to be extended to the whole Galliera Hospital.

Keywords: Waiting list management, Approach:priority, Product validation.

F1_C

Using Data Systems to improve Patient Centred Care

Orla Treacy, Mark Turner

Health Services Executive, Ireland
{Orla.Treacy, Mark.Turner}@hse.ie

We present the HealthStat system developed with the objective of providing meaningful accessible performance information for individual service units (hospitals and community services) as a basis for effective performance management and improvement in patient services for the public. HealthStat is a comprehensive databank; it provides detailed monthly results from Ireland's hospitals, community and social services publicly available online on www.hse.ie since January 2009. In the past, hospitals and community services in Ireland measured some of their activity, but the targets and the data collected varied; it was fragmented and did not enable a clear picture of how services were being delivered to patients, or how they compared to each other and best international standards. A culture and practice of performance management did not exist. HealthStat has been developed by the Health Service Executive (HSE), which is the largest organisation in Ireland, and was established in 2005 as the unitary public authority to deliver and finance all hospitals, primary health, and social services in Ireland. HealthStat has become a central performance management tool in the HSE. HealthStat is used as a core performance management tool by executives with line service managers, who then use it with their staff to improve service to patients. Each month, the performance results are generated through HealthStat and circulated to all executives and service managers. A HealthStat Forum is held monthly and led by the HSE CEO with key directors and attended by hospital CEOs, medical directors and community service managers. The HealthStat Forum challenges results, suggestions for improvements are discussed and best practice is identified. What sets HealthStat apart is the specific focus on performance management by line managers and subsequent follow up in achieving patient centred Healthcare.

Keywords: Performance measurement decision support in health service, Integrated performance data and statistics system, National, regional and local.

LIST OF AUTHOURS
&
PARTICIPANTS

LIST OF AUTHORS & PARTICIPANTS

Name	Affiliation	e-mail	Session
Abrunhosa Collazo Rodrigo	Centro de Análise de Sistemas Navais (CASVAV) - Marinha do Brasil	rodrigocollazo@uol.com.br	M3_B
Acar Ilgin Poyraz	Department of Industrial Engineering, Anadolu University, Turkey	ipoyraz@anadolu.edu.tr	TH2_C
Adan Ivo	Department of Mathematics and Computer Sciences, Eindhoven University of Technology, The Netherlands	iadan@tue.nl	W2_A
Addis Bernardetta	Dipartimento di Elettronica ed Informazione, Politecnico di Milano, Italy	addis@elet.polimi.it	T2_A
Agasisti Tommaso	Department of Management, Economics and Industrial Engineering, Politecnico di Milano, Italy	tommaso.agasisti@polimi.it	W1
Ahmed Salah Uddin	Social Marketing Company (SMC), Bangladesh	su.ahmed@smc-bd.org	F1_C
Ajami Sima	Medical Records Department or Health Management & Economics Research Centre, Faculty of Medical Management & Information Sciences, Isfahan University of Medical Sciences, Isfahan, Iran	Ajami@mng.mui.ac.ir	TH2_A, TH4_B
Alderighi Stefano	Università degli Studi di Genova, Italy	stealde85@gmail.com	
Allen Christine R.	Centre for Statistical Science and Operational Research (CenSSOR), Queen's University Belfast,UK		TH1_C
Alvarez Rene	Centre for Research in Healthcare Engineering, Department of Mechanical and Industrial Engineering, University of Toronto, Canada	renealvarezc@gmail.com	M3_A, W2_A
Amaldi Edoardo	DEI, Politecnico di Milano, Italy	amaldi@elet.polimi.it	T2_A
Aringhieri Roberto	Dipartimento di Informatica, Università degli Studi di Torino, Italy	roberto.aringhieri@di.unito.it	T1_A, T2_A, TH2_A, TH3_A
Aspergh Giada	Epidemiology and Community Medicine Unit, Department of Paediatrics University of Padova, Italy	epi@pediatria.unipd.it	T3
Azcárate Cristina	Department of Statistics and Operations Research, Public University of Navarre, Spain	cazcarate@unavarra.es	TH4_B
Bacioiu Georghe	Industrial and Manufacturing Systems Engineering Dept., University of Windsor, Canada	bacioiug@uwindsor.ca	F1_C
Balestra Gabriella	Dipartimento di Elettronica, Politecnico di Torino, Italy	gabriella.balestra@polito.it	M3_B
Barber Nick	London School of Pharmacy, UK		TH3_B
Barrios Rolando	BC Centre for Excellence on HIV/AIDS, Vancouver, Canada	rbarrios@cfenet.ubc.ca	M1_B
Barton Maria	School of Computing and Information Engineering, University of Ulster, Coleraine, UK	m.barton@ulster.ac.uk	TH1_A
Bastani Pouya	BC Centre for Excellence on HIV/AIDS, Vancouver, Canada	pbastani@irmacs.sfu.ca	M1_B
Bäumelt Zdeněk	Department of Control Engineering, Faculty of Electrical Engineering Czech Technical University in Prague, Czech Republic	baumezde@fel.cvut.cz	TH3_C
Bayer Steffen	Business School, Imperial College London, UK	s.bayer@imperial.ac.uk	TH2_B
Beaulieu Isabelle	HEC Montréal, Department of Management Sciences, Canada	valerie.3.belanger@hec.ca	M3_A
Begen Mehmet A.	Ivey School of Business, University of Western Ontario, Canada	mbegen@ivey.uwo.ca	M2_A
Bekker René	Dept. of Mathematic, VU University Amsterdam, The Netherlands	rbekker@few.vu.nl	TH4_B
Bekkers Jos	Department of Cardiothoracic Surgery, Erasmus University Medical Centre Rotterdam, The Netherlands	j.a.bekkers@erasmusmc.nl	W2_A
Bélanger Valérie	HEC Montréal, Department of Management Sciences, Canada	valerie.3.belanger@hec.ca	TH3_A

LIST OF AUTHORS & PARTICIPANTS

Name	Affiliation	e-mail	Session
Belton Valerie	Department of Management Science, University of Strathclyde, Scotland, UK		TH1_C
Bensa Giuliana	CERGAS (Centre for Research on Health and Social Care Management) Bocconi University, Italy	giuliana.bensa@unibocconi.it	M3_B, F1_A
Benzarti Emna	Laboratoire Génie Industriel, Ecole Centrale Paris, France	emna.benzarti@ecp.fr	TH3_C
Beraldi Patrizia	Dipartimento di Elettronica, Informatica, Sistemistica,Università della Calabria, Italy	beraldi@deis.unical.it	M3_A
Bhulai Sandjai	Department of Mathematics, VU University Amsterdam, The Netherlands	sbhulai@few.vu.nl	TH2_C
Bijl Kees	Department of Rehabilitation, Academic Medical Center Amsterdam, The Netherlands	C.J.Bijl@amc.nl	F1_A
Billaut Jean-Charles	Laboratoire informatique de Tours, Université François Rabelais Tours, France	jean-charles.billaut@univ-tours.fr	TH4_A
Blake John	Dalhousie University, Department of Industrial Engineering, Halifax, Nova Scotia, Canada	john.blake@dal.ca	TH4_A
Boldy Duncan	Centre for research on Ageingent, Curtin University, Australia	d.boldy@curtin.edu.au	W1
Bolt Timothy	School of Management, University of Southampton, UK	tim.bolt@soton.ac.uk	TH2_B
Boucherie Richard	Department of Applied Mathematics, Stochastic Operations Research, University of Twente, The Netherlands		F1_A
Bowen Tom	The Balance of Care Group, UK	tom.bowen@balanceofcare.com	T2_B, W1
Bowry Richard	St. Michael's Hospital, Toronto, ON, Canada; Faculty of Medicine, University of Toronto		W2_A
Braaksma Aleida	Department of Quality and Process Innovation – Patient Oriented Logistics, Academic Medical Center Amsterdam, The Netherlands	A.Braaksma@amc.nl	F1_A
Brailsford Sally	School of Management, University of Southampton, UK	s.c.brailsford@soton.ac.uk	M1_A, M2_B, M2_B, W2_B, TH2_B, TH3_B
Braione Alessandro	Department of Mechanical Engineering, DIMEC, University of Salerno, Italy		W2_A
Brardinoni Greta	University of Urbino "Carlo Bo", Italy	gretabrardi@yahoo.com	F1_B
Bruni Maria Elena	Dipartimento di Elettronica, Informatica, Sistemistica, Università della Calabria, Italy	mebruni@deis.unical.it	M3_A, TH3_A
Bull Kate	Great Ormond Street Hospital for Children, London UK	BullC@gosh.nhs.uk	T3
Burnell Steven J.	Focused_On Ltd, UK	SJBurnell@Focused-On.com	F1_C
Butt Steven E	Department of Industrial and Manufacturing Engineering, Western Michigan University, Kalamazoo, Michigan, USA	steven.butt@wmich.edu	TH2_C
Cairns Karen J.	Centre for Statistical Science and Operational Research (CenSSOR), Queen's University Belfast,UK	k.cairns@qub.ac.uk	TH1_C
Cakmak Elcin T.	Department of Econometrics - Uludag University, Bursa, Turkey		TH1_C
Canesi Barbara	Biolab (DIST, University of Genova, Italy) and Nextage Srl, Genova, Italy	barbara.canesi@dist.unige.it, barbara.canesi@nextage-on.com	F1_C
Carello Giuliana	Dipartimento di Elettronica ed Informazione, Politecnico di Milano, Italy	carello@elet.polimi.it	T2_A
Carter Michael	Centre for Research in Healthcare Engineering, Department of Mechanical and Industrial Engineering, University of Toronto, Canada	carter@mie.utoronto.ca	W2_A, TH3_B
Castillo-Chavez Carlos	School of Human Evolution and Social Change and School of Mathematical and Statistical Science, Arizona State University, USA	ccchavez@asu.edu	M2_B
Ceglowski Andrzej	Department of Accounting and Finance, Monash University, Australia	Andrzej.Ceglowski@buseco.monash.edu.au	F1_A

LIST OF AUTHORS & PARTICIPANTS

Name	Affiliation	e-mail	Session
Ceylan Arda	Institude of Naval Science and Engineering, Turkish Naval Academy, Tuzla, Istanbul, Turkey	aceylan@dho.edu.tr	M2_A
Chahed Salma	Health and Social Care Modelling Group, University of Westminster, London, UK	chaheds@wmin.ac.uk	TH2_B
Chaussalet Thierry	Health and Social Care Modelling Group, University of Westminster, London, UK	chausst@wmin.ac.uk	TH2_B
Chessa Michela	University of Milano, Italy	michela.chessa@unimi.it	T3
Chowell Gerardo	School of Human Evolution and Social Change and School of Mathematical and Statistical Science, Arizona State University, USA	gchowell@asu.edu	M2_B
Churilov Leonid	National Stroke Research Institute, Melbourne, Australia and The University of Melbourne, Australia	lchurilov@nsri.org.au	TH1_A
Ciavotta Michele	Grupo de Sistemas de Optimizacion Aplicada, Instituto Tecnologico de Informatica, Universidad Politecnica de Valencia, Spain	mciavotta@iti.upv.es	T1_A
Claro Garcia Leonardo	Centro de Análise de Sistemas Navais (CASVAV) - Marinha do Brasil	leoclaro@terra.com.br	M3_B
Conforti Domenico	Dipartimento di Elettronica, Informatica, Sistemistica,Università della Calabria,Italy	mimmo.conforti@unical.it	M2_A, M3_A, T1_A
Coniglio Stefano	DEI, Politecnico di Milano, Italy	coniglio@elet.polimi.it	T2_A
Corradi Luca	Biolab (DIST, University of Genova, Italy) and Nextage Srl, Genova, Italy		F1_C
Corsi Mario	University of Urbino "Carlo Bo", Italy	mario.corsi@uniurb.it	F1_B, F1_B
Costantino Nicola	Dipartimento di Ingegneria Meccanica e Gestionale, Politecnico di Bari, Italy	costantino@poliba.it	TH4_A
Crowe Julien	Méthodes quantitatives de gestion, HEC Montréal, Canada	julien.crowe@hec.ca	TH2_C
Crowe Sonya	Clinical Operational Research Unit, University College London, UK	sonya.crowe@ucl.ac.uk	M2_B, T3
Currie Christine	School of Mathematics, University of Southampton, UK	c.s.m.currie@soton.ac.uk	M2_B
Dahl Fredrik A.	Helse Sor-Ost Health Service Research Centre, Akershus University Hospital, Norway	fredrik.dahl@ahus.no	TH1_C
Dallery Yves	Laboratoire Génie Industriel, Ecole Centrale Paris, France	yves.dallery@ecp.fr	TH3_C
Dasaklis Tom	Dept. of Industrial Management, University of Piraeus, Greece	dasaklis@unipi.gr	M1_B
Davie Paul	School of Management, University of Southampton, UK	p.a.davie@soton.ac.uk	M2_B
De Angelis Vanda	Dipartimento di Statistica, Probabilità e Statistiche Applicate, Università "La Sapienza", Italy	vanda.deangelis@uniroma1.it	M2_B
de Senna Valter	Computer Modelling Dept., Senai-Cimatec, Bahia, Brazil	valter.senna@gmail.com	M1_B
Delesie Luc	Center for Health Services Research, Catholic University of Leuven, Belgium	luc.delesie@med.kuleuven.be	F1_B
Dellaert Nico	Department of Technology Management, Eindhoven University of Technology, The Netherlands	n.p.dellaaert@tm.tue.nl	W2_A
Dellino Gabriella	Dipartimento di Ingegneria dell'Informazione, Università di Siena, Italy	dellino@dii.unisi.it	T1_A
Demeulemeester Erik	FBE, Catholic University of Louvain, Belgium	Erik.Demeulemeester@econ.kuleuven.be	T1_B
Demir Eren	Health and Social Care Modelling Group, University of Westminster, London, UK	demirer@wmin.ac.uk	TH2_B
Dewey Helen M.	National Stroke Research Institute, Melbourne, Australia and The University of Melbourne, Australia and Austin Health, Melbourne, Australia		TH1_A
di Bella Enrico	Department of Economics and Quantitative methods, University of Genova, Italy	edibella@economia.unige.it	TH3_A

LIST OF AUTHORS & PARTICIPANTS

Name	Affiliation	e-mail	Session
Di Gennaro Alessia	Università degli Studi di Genova	casamangini@inwind.it	
Dotoli Mariagrazia	Dipartimento di Elettrotecnica ed Elettronica, Politecnico di Bari, Italy	dotoli@deemail.poliba.it	TH4_A
Edgar Alfonso	Engineering and Health Division, École Nationale Supérieure des Mines de Saint-Étienne, France	alfonso@emse.fr	TH4_A
Eeckloo Kristof	Center for Health Services Research, Catholic University of Leuven, Belgium	kristof.eeckloo@med.kuleuven.be	F1_B
Facchin Paola	Epidemiology and Community Medicine Unit, Department of Paediatrics University of Padova, Italy	epi@pediatria.unipd.it	T3, T3
Falagario Marco	Dipartimento di Ingegneria Meccanica e Gestionale, Politecnico di Bari, Italy	m.falagario@poliba.it	TH4_A
Fanti Maria Pia	Dipartimento di Elettrotecnica ed Elettronica, Politecnico di Bari, Italy	fanti@deemail.poliba.it	TH2_B, TH4_A
Fatemi-Ghomi Mohammad-Taghi	Faculty of Industrial Engineering, Amirkabir University of Technology, Iran	fatemi@aut.ac.ir	T1_A
Fè Martina	Università degli Studi di Genova, Italy	fe.martina@yahoo.it	
Fenton Matthew	Great Ormond Street Hospital for Children, London UK	FentoM@gosh.nhs.uk	T3
Ferrante Anna	Epidemiology and Community Medicine Unit, Department of Paediatrics University of Padova, Italy	epi@pediatria.unipd.it	T3, T3
Ferreira de Oliveira Mário Jorge	Federal University of Rio de Janeiro, Rio de Janeiro (Brazil) Programa de Engenharia de Produção – COPPE/UFRJ	mario_jo@pep.ufrj.br	M3_B
Fiorentino Francesca	Clinical Operational Research Unit, Department of Mathematics, University College London, UK	f.fiorentino@ucl.ac.uk	W2_B
Forte Paul	The Balance of Care Group, UK	Paul.forte@balanceofcare.com	T3, W1
Fossati Amedeo	Department of Economics and Quantitative methods, University of Genova, Italy	fossati@economia.unige.it	TH1_B
Fouladinejad Farid	Health and Social Care Modelling Group, University of Westminster, London, UK	farid.fouladinejad@hounslowpct.nhs.uk	TH2_B
Fragnelli Vito	University of Eastern Piedmont, Italy	vito.fragnelli@mfn.unipmn.it	TH3_A
Francese Maura	Structural Economic Analysis Department, Banca d'Italia, Italy	maura.francese@bancaditalia.it	TH1_B
Franci Alberto	University of Urbino "Carlo Bo", Italy	alberto.franci@uniurb.it	F1_B, F1_B
Friðriksdóttir Auður	National Stroke Research Institute, Melbourne, Australia and The University of Melbourne, Australia		TH1_A
Fruggiero Fabio	Department of Engineering and Environmental Physics, DIFA, University of Basilicata, Italy	fabio.fruggiero@unibas.it	W2_A
Fullerton Ken	School of Medicine, Dentistry, and Biomedical Sciences, Queen's University, Belfast, UK	ken.fullerton@belfasttrust.hscni.net	TH1_A
Gaetano Laura	Dipartimento di Meccanica, Politecnico di Torino, Italy	laura.gaetano@polito.it	M3_B
Gagliardo Stefano	University of Genova, Italy	gagliardo@dima.unige.it	T3, TH3_A
Galletti Alessandra	ADI, Azienda Sanitaria Locale Ferrara, Italy	a.galletti@ausl.fe.it	TH3_C
Gallivan Steve	Clinical Operation Research Unit, University College London, UK		T3, TH2_B, TH3_B
Garavaglia Giulia	Department of Management, Economics and Industrial Engineering, Politecnico di Milano, Italy	giulia.garavaglia@polimi.it	W1
Garg Lailt	School of Medicine, Dentistry, and Biomedical Sciences, Queen's University, Belfast, UK		TH1_A
Gartner Daniel	TUM School of Management, Technische Universität München, Germany	daniel.gartner@wi.tum.de	M1_A
Gatti Elena	Dipartimento di Informatica, Sistemistica e Comunicazione, Università degli Studi di Milano-Bicocca, Italy	elena.gatti@disco.unimib.it	TH1_A
Gendreau Michel	École Polytechnique, Applied Mathematics and Industrial Engineering Department, Canada	michel.gendreau@cirrelt.ca	M3_A

LIST OF AUTHORS & PARTICIPANTS

Name	Affiliation	e-mail	Session
Gillard Jonathan	School of Mathematics, Cardiff University, Senghennydd Road, CARDIFF, Wales, UK	GillardJW@cf.ac.uk	TH2_A
Giusepi Isabella	CERGAS (Centre for Research on Health and Social Care Management) Bocconi University, Italy	isabella.giusepi@unibocconi.it	M3_B, F1_A
Gonzalez-Parra Paula A.	Program in Computational Science, The University of Texas at El Paso, USA	pagonzalezparra@miners.utep.edu	M2_B
Gribaudo Marco	Dipartimento di Elettronica e Informazione, Politecnico di Milano, Italy	gribaudo@elet.polimi.it	TH2_A
Griffiths Jeff	School of Mathematics, Cardiff University, Wales, UK		W2_A
Grosso Andrea	Dipartimento di Informatica, Università degli Studi di Torino, Italy	grosso@di.unito.it	T2_A
Grove Peter	Health Protection Analytical Team, UK Department of Health, London, UK		M2_B
Guerriero Francesca	Dipartimento di Elettronica, Informatica, Sistemistica, Università della Calabria, Italy	guerriero@deis.unical.it	M2_A, T1_A
Guido Rosita	Dipartimento di Elettronica, Informatica, Sistemistica, Università della Calabria, Italy	rosita.guido@deis.unical.it	M2_A, T1_A
Gumirato Gino	Local Health Unit (ASL) Roma, Italy	Gino.gumirato@tiscali.it	PLENARY
Günal Murat M.	Department of Industrial Engineering, Turkish Naval Academy, Tuzla, Istanbul, Turkey	mgunal@dho.edu.tr	M2_A, TH1_C
Gurrieri Caterina	University of Urbino "Carlo Bo", Italy	c.gurrieri@hotmail.it	F1_B, F1_B
Guzman Castillo Maria de Lourdes	School of Management, University of Southampton, UK	mdlgc106@soton.ac.uk	M1_A
Hans Erwin W.	Center for Healthcare Operations Improvement and Research (CHOIR), University of Twente, The Netherlands	e.w.hans@utwente.nl	F1_A
Hanzálek Zdeněk	Department of Control Engineering, Faculty of Electrical EngineeringCzech Technical University in Prague, Czech Republic and Merica Ltd., Czech Republic	hanzalek@fel.cvut.cz, hanzalek@merica.cz	TH3_C
Hardy Matthew	Dalhousie University, Department of Industrial Engineering, Halifax, Nova Scotia, Canada	Matthew.Hardy@dal.ca	TH4_A
Harindra Veerkathy	Department of GUM, St Mary's Hospital, UK	veerakathy.harindra@porthosp.nhs.uk	TH3_B
Harper Paul	Cardiff School of Mathematics, Cardiff University, UK	harper@cardiff.ac.uk	T2_B, TH2_A, TH3_B
Haspeslagh Marc	az sint jan brugge-oostende av, Bruges, Belgium	marc@haspeslagh.net	F1_B
Haybyrne James	Health Protection Analytical Team, UK Department of Health, London, UK		M2_B
Helm Jonathan E.	Industrial and Operations Engineering Department, University of Michigan, USA	jhelm@umich.edu	TH4_B
Heng Bee Hoon	Health Services & Outcomes Research, National Healthcare Group, Singapore		M2_A
Holm Lene Berge	Helse Sor-Ost Health Service Research Centre, Akershus University Hospital, Norway	lene.berge.holm@ahus.no	TH1_C
Howick Susan	Department of Management Science, University of Strathclyde, Scotland, UK		TH1_C
Iacobellis Giorgio	Dipartimento di Elettrotecnica ed Elettronica, Politecnico di Bari, Italy	iacobellis@deemail.poliba.it	TH2_B
Iuliano Claudio	DEI, Politecnico di Milano, Italy	iuliano@elet.polimi.it	T2_A
Ivaldi Enrico	Department of Economics and Quantitative Methods, University of Genova, Italy	ivaldi@economia.unige.it	W1
Jafari Mohsen	Industrial & Systems Engineering Department, Rutgers University, USA	jafari@rci.rutgers.edu	TH3_C
Jeunet Jully	CNRS, Lamsade, Université Paris Dauphine France	jully.jeunet@dauphine.fr	W2_A
Kapsali Maria	Business School, Imperial College London, UK	m.kapsali@imperial.ac.uk	TH2_B
Kaya Sule	Department of Econometrics - Uludag University, Bursa, Turkey		TH1_C

LIST OF AUTHORS & PARTICIPANTS

Name	Affiliation	e-mail	Session
Kergosien Yannick	Laboratoire informatique de Tours, Université François Rabelais Tours, France	yannick.kergosien@univ-tours.fr	TH4_A
Ketabi Saeedeh	Department of Management, Faculty of Administrative Sciences and Economics, University of Isfahan, Iran	sketabi@yahoo.com	T1_A, TH2_A, TH4_B
Khurma Nancy	Industrial and Manufacturing Systems Engineering Dept., University of Windsor, Canada	khurma@uwindsor.ca	T1_B
Knight Vincent	School of Mathematics, Cardiff University, UK	knightva@cf.ac.uk	TH1_B, TH2_A
Kolisch Rainer	TUM School of Management, Technische Universität München, Germany	rainer.kolisc@wi.tum.de	M1_A
Kortbeek Nikky	Department of Applied Mathematics – Stochastic Operations Research, University of Twente, The Netherlands	N.Kortbeek@utwente.nl	F1_A, F1_A, F1_A
Kozan Erhan	Mathematical Sciences, Faculty of Science and Technology, Queensland University of Technology, Australia	e.kozan@qut.edu.au	TH2_A
Kranenburg Jelmer			F1_A
Lagergren Mårten	Stockholm Gerontology Research Center, Sweden	marten.lagergren@aldrecentrum.se	W1
Lambiase Alfredo	University of Salerno, Department of Mechanical Engineering, DIMEC		W2_A
Landa Paolo	Department of Economics and Quantitative Methods, University of Genova, Italy	paolo.landa@yahoo.it	T1_A
Langfield-Smith Kim	Department of Accounting and Finance, Monash University, Australia	Kim.Langfield-Smith@buseco.monash.edu.au	F1_A
Lanzarone Ettore	Dipartimento di Meccanica, Politecnico di Milano, Italy		TH3_C
Lenté Christophe	Laboratoire informatique de Tours, Université François Rabelais Tours, France	christophe.lente@univ-tours.fr	TH4_A
Lettieri Emanuele	Department of Management, Economics and Industrial Engineering, Politecnico di Milano, Italy	emanuele.lettieri@polimi.it	W1
Levi Retsef	Sloan School of Management, MIT, USA	retsef@mit.edu	M2_A
Litvak Nelly	Department of Applied Mathematics, Stochastic Operations Research, University of Twente, The Netherlands		F1_A
Lopez Salvatore Silvano	Local Health Unit Milano 1, Italy	silvano.lopez@aslmi1.mi.it	W1
Lubicz Marek	Department for Computer Science and Management,Wrocław University of Technology, Poland and Regional Specialist Hospital in Wroclaw,Research and Development Center, Poland	marek.lubicz@pwr.wroc.pl	W2_B
Luciani Davide	Laboratorio di Epidemiologia Clinica, Istituto di Ricerche Farmacologiche Mario Negri, Italy	davide.luciani@marionegri.it	TH1_A
Lučić Mario	DEI, Politecnico di Milano, Italy	mario.lucic@gmail.com	TH3_C
Ma Guoxuan	FBE, Catholic University of Louvain, Belgium	Guoxuan.Ma@econ.kuleuven.be	T1_B
Maffioli Francesco	Dipartimento di Elettronica ed Informazione, Politecnico di Milano, Italy	maffioli@elet.polimi.it	T2_A
Mahnam Mehdi	Faculty of Industrial Engineering, Amirkabir University of Technology, Iran	mmahnam@aut.ac.ir	T1_A
Mallor Fermín	Department of Statistics and Operations Research, Public University of Navarre, Spain	mallor@unavarra.es	TH4_B
Malmström Raija	Hospital District of Helsinki and Uusimaa, Finland	raija.malmstrom@hus.fi	T2_A
Malmström Tomi	BIT Research Centre, Aalto University, Finland	tomi.malmstrom@tkk.fi	T2_A
Malucelli Federico	DEI, Politecnico di Milano, Italy	malucell@elet.polimi.it	TH3_C
Mangini Agostino Marcello	Dipartimento di Elettrotecnica ed Elettronica, Politecnico di Bari, Italy	mangini@deemail.poliba.it	TH4_A

LIST OF AUTHORS & PARTICIPANTS

Name	Affiliation	e-mail	Session
Marshall Adele H.	Centre for Statistical Science and Operational Research (CenSSOR), Queen's University Belfast, UK		TH1_C
Masella Cristina	Department of Management, Economics and Industrial Engineering, Politecnico di Milano, Italy	cristina.masella@polimi.it	W1
Matta Andrea	Dipartimento di Meccanica, Politecnico di Milano, Italy	andrea.matta@polimi.it	TH3_C
Mazzetti Ornella	SIET, Galliera Hospital, Genova, Italy		F1_C
McClean Sally	School of Computing and Information Engineering, University of Ulster, Coleraine, UK		TH1_A
Mecoli Mariagrazia	Dipartimento di Statistica, Probabilità e Statistiche Applicate, Università "La Sapienza", Italy	mariagrazia.mecoli@uniroma1.it	M2_B
Meloni Carlo	Dipartimento di Elettrotecnica ed Elettronica, Politecnico di Bari, Italy	meloni@deemail.poliba.it	T1_A
Mielczarek Bożena	Department for Computer Science and Management,Wrocław University of Technology, Poland	bozena.mielczarek@pwr.wroc.pl	W2_B
Mishra Nishikant	Automated Scheduling, Optimization and Planning Research Group School of Computer Science, University of Nottingham, Nottingham, UK	nxm@cs.nott.ac.uk	W2_B
Moggia Daniele	Università degli Studi di Genova, Italy	danimoggia@hotmail.it	
Mohiuddin Syed	School of Management, University of Southampton, UK	s.g.mohiuddin@soton.ac.uk	W2_B
Montanari Caterina	ADI, Azienda Sanitaria Locale Ferrara, Italy	c.montanari@ausl.fe.it	TH3_C
Montefiori Marcello	Department of Economics and Quantitative methods, University of Genova, Italy	montefiori@unige.it	TH1_B, TH3_A
Monteiro Pessôa Leonardo Antonio	Centro de Análise de Sistemas Navais (CASVAV) - Marinha do Brasil	lampessoa@gmail.com	M3_B
Morgan Jennifer	Department of Management Science, University of Strathclyde, Scotland, UK	Jennifer.s.morgan@strath.ac.uk	TH1_C
Mullen Penelope	University of Birmingham UK	penelope.mullen@btinternet.com	T2_B
Murante Anna Maria	Laboratorio Management e Sanità, Scuola Superiore Sant'Anna, Pisa, Italy	c.panero, a.murante}@sssup.it	F1_B
Nonato Maddalena	Dipartimento di Ingegneria, Università di Ferrara, Italy	maddalena.nonato@unife.it	TH3_C
Onart Selcuk	Department of Econometrics, Uludag University, Bursa, Turkey		TH1_C
Out Paulien	CC Zorgadviseurs, The Netherlands and Department of Mathematics, VU University Amsterdam, The Netherlands	p.out@cczorgadviseurs.nl, paulien@few.vu.nl	TH2_C, TH4_B
Ozcan Yasar A.	Department of Health Administration, Virginia Commonwealth University, USA	Ozcan@vcu.edu	M1_A
Pagel Christina	Clinical Operation Research Unit, University College London, UK		M2_B, T3, TH2_B, TH3_B
Panero Cinzia	Laboratorio Management e Sanità, Scuola Superiore Sant'Anna - Pisa- Italy	c.panero, a.murante}@sssup.it	F1_B
Pappis Costas	Dept. of Industrial Management, University of Piraeus, Greece	pappis@unipi.gr	M1_B
Pasek Zbigniew J.	Industrial and Manufacturing Systems Engineering Dept., University of Windsor, Canada	zjpasek@uwindsor.ca	T1_B, F1_C
Patrick Jonathan	Telfer School of Management, University of Ottawa, Canada	patrick@telfer.uottawa.ca	T1_B
Perucca Giovanni	Dipartimento di Scienze Economiche e Finanzirie "G.Prato", University of Turin, Italy and Department of Economics, Business and Statistics, University of Milan – Italy	giovanni.perucca@unimi.it	F1_B

LIST OF AUTHORS & PARTICIPANTS

Name	Affiliation	e-mail	Session
Petrovic Sanja	Automated Scheduling, Optimization and Planning Research Group School of Computer Science, University of Nottingham, Nottingham, UK	sxp@cs.nott.ac.uk	W2_B
Piszko Piotr	Regional Specialist Hospital in Wroclaw,Research and Development Center, Poland		W2_B
Pitt Martin	Peninsula Medical School, Exeter, UK	martin.pitt@pms.ac.uk	TH1_A
Porro Ivan	Biolab (DIST, University of Genova, Italy) and Nextage Srl (Genova, Italy)		F1_C
Post Gerhard	Department of Applied Mathematics, Discrete Mathematics and Mathematical Programming, University of Twente, The Netherlands	G.F.Post@utwente.nl	F1_A
Pranzo Marco	Dipartimento di Ingegneria dell'Informazione, Università di Siena, Italy	pranzo@dii.unisi.it	T1_A
Prenestini Anna	CERGAS (Centre for Research on Health and Social Care Management), Bocconi University, Italy		F1_A
Puga-Bolio David E.	Department of Management Science, Lancaster University Management School, UK	d.puga-bolio@lancaster.ac.uk	F1_B
Queyranne Maurice	Sauder School of Business, University of British Columbia, Canada	maurice.queyranne@sauder.ubc.ca	M2_A
Rachaniotis Nikolaos	Dept. of Industrial Management, University of Piraeus, Greece	nraxan@unipi.gr	M1_B
Ramadanovic Bojan	IRMACS Centre, Simon Fraser University, Canada	bramadan@irmacs.sfu.ca	M1_B
Rekik Monia	Université Laval, Operations and Decision Systems Departement, Canada and Interuniversity Research Center on Enterprise Networks, Logistics and Transportation (CIRRELT), Canada	monia.rekik@fsa.ulaval.ca	T2_A
Renaud Jacques	Université Laval, Operations and Decision Systems Departement, Canada and Interuniversity Research Center on Enterprise Networks, Logistics and Transportation (CIRRELT), Canada	jacques.renaud@fsa.ulaval.ca	T2_A
Resta Marina	DIEM, University of Genova, Italy	mresta@unige.it	TH1_B
Richards David	School of Psychology, University of Exeter, UK	d.a.richards@exeter.ac.uk	TH2_B
Rizzato Elena	Epidemiology and Community Medicine Unit, Department of Paediatrics University of Padova, Italy	epi@pediatria.unipd.it	T3
Romanelli Marzia	Structural Economic Analysis Department, Banca d'Italia, Italy	marzia.romanelli@bancaditalia.it	TH1_B
Romanin-Jacur Giorgio	Department of Management and Engineering, University of Padova, Italy	romjac@dei.unipd.it	T3, T3
Rosso Nicola	SIET, Galliera Hospital, Genova, Italy	nicola.rosso@galliera.it	F1_C
Rotaru Kristian	Department of Accounting and Finance, Monash University, Australia	Kristian.Rotaru@buseco.monash.edu.au	F1_A
Ruiz Angel	Université Laval, Operations and Decision Systems Departement, Canada and Interuniversity Research Center on Enterprise Networks, Logistics and Transportation (CIRRELT), Canada	angel.ruiz@fsa.ulaval.ca	T2_A, TH3_A
Rutherford A. R.	IRMACS Centre and Dept. of Mathematics, Simon Fraser University, Canada	sandyr@irmacs.sfu.ca	M1_B
Sadeghian Akram	Medical Records Department or Health Management & Economics Research Centre, Faculty of Medical Management & Information Sciences, Isfahan University of Medical Sciences, Isfahan, Iran	sadeghian_akram@yahoo.com	TH4_B
Saghaeinnejad Isfahani Sakine	Medical Records Department, Faculty of Medical Management & Information Sciences, Isfahan University of Medical Sciences, Isfahan, Iran	saghaeiannejad@mng.mui.ac.ir	TH4_B

LIST OF AUTHORS & PARTICIPANTS

Name	Affiliation	e-mail	Session
Sahin Evren	Laboratoire Génie Industriel, Ecole Centrale Paris, France	evren.sahin@ecp.fr	TH3_C
Salmaso Laura	Epidemiology and Community Medicine Unit, Department of Paediatrics University of Padova, Italy	epi@pediatria.unipd.it	T3
Sciancalepore Fabio	Dipartimento di Ingegneria Meccanica e Gestionale, Politecnico di Bari, Italy	f.sciancalepore@poliba.it	TH4_A
Seyed Kian	Industrial & Systems Engineering Department, Rutgers University, USA	kian_seyed@yahoo.com	TH3_C
Sezen H.Kemal	Department of Econometrics - Uludag University, Bursa, Turkey	kemal@uludag.edu.tr	TH1_C
Shahani Arjan	School of Mathematics and GeoData Institute, University of Southampton, UK	akshahani2@googlemail.com	TH3_B
Smith Honora	School of Mathematics, University of Southampton, UK	honora.smith@soton.ac.uk	M1_A, T2_B
Soriano Patrick	HEC Montréal, Department of Management Sciences, Canada	patrick.soriano@hec.ca	M3_A, T1_A, TH2_C, TH3_A
Stella Fabio	Dipartimento di Informatica, Sistemistica e Comunicazione, Università degli Studi di Milano-Bicocca, Italy	stella@disco.unimib.it	TH1_A
Šůcha Přemysl	Department of Control Engineering, Faculty of Electrical Engineering Czech Technical University in Prague, Czech Republic	suchap@fel.cvut.cz	TH3_C
Sundar Santhanam	Department of Oncology, Nottingham University Hospital NHS Trust Nottingham, UK	Santhanam.sundar@nuh.nhs.uk	W2_B
Tànfani Elena	Department of Economics and Quantitative Methods, University of Genova, Italy	etanfani@economia.unige.it	M3_A, T1_A, W1
Teow Kiok Liang	Health Services & Outcomes Research, National Healthcare Group, Singapore		M2_A
Testi Angela	Department of Economics and Quantitative Methods, University of Genova, Italy	testi@economia.unige.it	M3_A, T1_A, W1
Torkki Paulus	BIT Research Centre, Aalto University, Finland and Hospital District of Helsinki and Uusimaa, Finland	paulus.torkki@tkk.fi	T2_A
Treacy Orla	Health Services Executive, Ireland	Orla.Treacy@hse.ie	F1_C
Treasure Tom	Clinical Operational Research Unit, Department of Mathematics, University College London, UK		W2_B
Turner Mark	Health Services Executive, Ireland	Mark.Turner@hse.ie	F1_C
Ukovich Walter	Dipartimento di Elettrotecnica, Elettronica e Informatica, Università di Trieste, Italy	ukovich@univ.trieste.it	TH2_B, TH4_A
Utley Martin	Clinical Operation Research Unit, University College London, UK	m.utley@ucl.ac.uk	M2_B, T3, W2_B, TH2_B, TH3_B
van Ackere Ann	HEC, University of Lausanne, Switzerland	ann.vanackere@unil.ch	M1_B
van der Veen Egbert	Department of Applied Mathematics, University of Twente, The Netherlands & ORTEC bv, The Netherlands	Egbert.vanderVeen@ortec.com	TH2_C
Van Essen Theresia	University of Twente, The Netherlands	j.t.vanessen@ewi.utwente.nl	
Van Oyen Mark P.	Industrial and Operations Engineering Department, University of Michigan, USA	vanoyen@umich.edu	TH4_B
Van Sambeek Jasper R.			F1_A
Vanberkel Peter	Department of Applied Mathematics, Department of Operational Methods for Production and Logistics University of Twente, The Netherlands	p.t.vanberkel@utwente.nl	T1_B
Vanderby Sonia	Centre for Research in Healthcare Engineering, Department of Mechanical & Industrial Engineering, University of Toronto, Canada	sonia@mie.utoronto.ca	TH3_B

LIST OF AUTHORS & PARTICIPANTS

Name	Affiliation	e-mail	Session
Vasarhelyi Krisztina	BC Centre for Excellence on HIV/AIDS and Faculty of Health Sciences, Simon Fraser University, Vancouver, Canada	kvasarhelyi@irmacs.sfu.ca	M1_B
Vasilakis Christos	Clinical Operational Research Unit, University College London, UK	c.vasilakis@ucl.ac.uk	T3, TH2_B
Velazquez Leticia	Deparment of Mathematical Sciences , The University of Texas at El Paso, USA	leti@utep.edu	M2_B
Veltman Bart	Department of Applied Mathematics, University of Twente, The Netherlands & ORTEC bv, The Netherlands	Bart.Veltman@ortec.com	TH2_C
Viana Joe	School of Management, University of Southampton, UK	J.Viana@soton.ac.uk	TH3_B
Vieira Israel T.	School of Mathematics, Cardiff University, UK	israel@itvieira.org	M1_B
Viladent Christian	School of Business and Technology, Webster University, Geneva, Switzerland	viladent@webster.ch	M1_B
Villa Stefano	CERGAS (Centre for Research on Health and Social Care Management) Bocconi University, Italy	stefano.villa@unibocconi.it	M3_B, F1_A
Villalobos Maria C.	Deparment of Mathematics, The University of Texas-Pan American, USA	mcvilla@panam.edu	M2_B
Vincent Augusto	Engineering and Health Division, École Nationale Supérieure des Mines de Saint-Étienne, France	augusto@emse.fr	TH4_A
Visonà-Dalla-Pozza Laura	Epidemiology and Community Medicine Unit, Department of Paediatrics University of Padova, Italy	epi@pediatria.unipd.it	T3
Vissers Jan	Institute of Health Policy and Management, Erasmus University Rotterdam NL	vissers@bmg.eur.nl	W2_A
Vliegen Ingrid	University of Twente, The Netherlands	i.m.h.vliegen@utwente.nl	
Voake Cheryl	School of Mathematics, Cardiff University, Wales, UK	voakec@cardiff.ac.uk	W2_A
Walker Guy	Health Protection Analytical Team, UK Department of Health, London, UK		M2_B
Waszniowski Libor	Department of Control Engineering, Faculty of Electrical Engineering Czech Technical University in Prague, Czech Republic and Merica Ltd., Czech Republic	xwasznio@fel.cvut.cz, waszniowski@merica.cz	TH3_C
Williams Janet	School of Mathematics, Cardiff University, Wales, UK		W2_A
Williams Julie	School of Mathematics, Cardiff University, Senghennydd Road, CARDIFF, Wales, UK	WilliamsJL5@cardiff.ac.uk	TH2_A
Wolfler Calvo Roberto	Université Paris Nord, Computer Science lab of the Paris Nord University (LIPN), France	roberto.wolfler@lipn.univ-paris-13.fr	TH3_A
Worrall Philip	School of Computer Science, University of Westminster, UK	philip.worrall@nhs.net	M1_A
Worthington Dave	Department of Management Science, Lancaster University, UK	d.worthington@lancaster.ac.uk	M1_A
Xiaolan Xie	Engineering and Health Division, École Nationale Supérieure des Mines de Saint-Étienne, France	xie@emse.fr	TH4_A
Zabawa Jacek	Department for Computer Science and Management,Wrocław University of Technology, Poland	jacek.zabawa@pwr.wroc.pl	W2_B
Zhu Zhecheng	Health Services & Outcomes Research, National Healthcare Group, Singapore	Zhecheng_zhu@nhg.com.sg	M2_A
Zonderland Maartje	Department of Applied Mathematics, Stochastic Operations Research, University of Twente and Division I, Leiden University Medical Center, Leiden, The Netherlands		F1_A