ORAHS 2012 CONFERENCE

- HIGH TECH HUMAN TOUCH -

38^{th} International Conference of the
EURO Working Group on
Operational Research Applied to Health Services

15-20 July 2012
University of Twente
Enschede, The Netherlands

Sponsors

We thank the following sponsors for their kind and generous support of the ORAHS 2012 International Conference and the symposium 'Operations Research Applied to Health Services: From Theory to Implementation':

Contents

Welcome **2**

Organizing Committee **3**

Practical Information **5**

Program **9**

Program at a Glance . . . 9
Social Program . . . 10
Scientific Program . . . 12
Keynote Speakers . . . 12
Monday July 16th . . . 15
Tuesday July 17th . . . 35
Thursday July 19th . . . 61
Friday July 20th . . . 79

List of Participants **87**

Maps **93**

Welcome

Dear colleague,

Welcome to ORAHS 2012, the 38^{th} annual meeting of the EURO-ORAHS working group!

Although none of us were around the first time, we are honored that this is the second time that the University of Twente (UT) has hosted the ORAHS meeting. Since the last meeting in 1985, many things have changed at the UT. One important change is that the research focus of our university is increasingly targeted towards healthcare applications. Of all researchers at the University, one in three is working in healthcare! Part of this research activity is organized within the CHOIR (Center for Healthcare Operations Improvement & Research) group, the organizers of ORAHS 2012.

The theme of this years' conference is *"High Tech - Human Touch"*. During four plenary talks, policy makers, academics and practitioners will discuss the challenges and opportunities that new technologies bring to the healthcare sector. How the OR community can add value to this, and how OR research can lead to an improved working environment and better quality of care are some of the questions we strive to address. Furthermore, the implementation of solutions and the involved human factors are discussed.

Since CHOIR focuses its research on real-life applications and has many contacts in healthcare organizations, we aim to use ORAHS 2012 to bring academics and practitioners together. To this end, a track targeted at practitioners is organized parallel to the academic program on Tuesday. The focus will be on applications of OR in healthcare, and will combine research-oriented presentations with presentations of healthcare organizations using this research. During the day, participants may switch between the two programs. All breaks and plenary sessions are scheduled concurrently for both groups.

Following the tradition of ORAHS, we offer an extensive social program, which of course includes a boat trip where you can be captain of your own boat. The highlights of the program include a day trip to Giethoorn, where you will have the opportunity to explore the town and surrounding national park in small boats, and Thursday's conference dinner in the beautiful 'Parklocatie De Jaargetijden'.

As you may have noticed, we've changed some elements of the 'traditional' ORAHS meeting program. The poster session now includes 'elevator pitches', an optional innovation lab tour replaces the usual hospital tour, and the digital proceedings are distributed on a USB stick. We hope you'll evaluate these 'experiments' with us during the ORAHS business meeting on Friday so that we can further improve the conference in future years.

Of course, this program would not have been possible without the help of our sponsors and we thank them for their contributions. Furthermore, we thank all members of CHOIR for their help in organizing this meeting. We couldn't have done this without you!

We wish you an interesting, fruitful, and memorable time in Enschede!

Erwin Hans & Ingrid Vliegen

Organizing Committee

Erwin Hans *(conference chair)*
Ingrid Vliegen *(conference chair)*

Richard Boucherie
Aleida Braaksma
Nico van Dijk
Theresia van Essen
Johann Hurink
Nikky Kortbeek
Nelly Litvak
Egbert van der Veen
Renske Visser
Maartje van de Vrugt

CHOIR Research Group *From left to right:*
Front row - Maartje Zonderland, Theresia van Essen, Aleida Braaksma, Nelly Litvak
2nd row - Nikky Kortbeek, Erwin Hans, Renske Visser, Johann Hurink, Ingrid Vliegen, Maartje van de Vrugt
Back row - Bart Veltman, Richard Boucherie, Egbert van der Veen, Gerhard Post

International Program Committee

Roberto Aringhieri (Italy)
John Blake (Canada)
Sally Brailsford (United Kingdom)
Michael Carter (Canada)
Erik Demeulemeester (Belgium)
Erwin Hans (The Netherlands)
Marten Lagergren (Sweden)
Marion Rauner (Austria)
Angela Testi (Italy)
Martin Utley (United Kingdom)
Jan Vissers (The Netherlands)
Xiaolan Xie (France)

Practical Information

Conference Venue All sessions of the scientific program take place on the campus of the University of Twente. See page 93 for an overview map of all buildings. All parallel sessions take place in the building Carré (Building 15) in Rooms 1A, 1B, 1C and 1D (ground floor). The plenary talks, including the poster pitch session and the discussion session, take place in the Waaier (Building 12) in Room 2. All rooms will be signposted during the conference.

Getting around the Campus / Enschede / Hengelo The campus of the University of Twente is compact, and all locations can be reached on foot. Furthermore, both Enschede and Hengelo are small cities, which can easily be explored on foot.

To reach the campus from Enschede, you can use bus Line 1 (to University of Twente, exit at stop UT/Hallenweg and in the weekend and evenings exit at stop UT/Calslaan) and bus Line 9 (to Hengelo station, exit at stop UT/Kennispark). To reach the campus from Hengelo, you can use bus Line 9 (to Enschede station, exit at stop UT/Kennispark). Information on (bus/train) schedules can be found at www.9292ov.nl/en.

Buses in the Netherlands If you do not plan to travel a lot with buses while visiting Enschede (5 times or less), we recommend you to pay cash at the bus driver (€ 2.20/€ 3.30 per one-way ticket Enschede/Hengelo to the campus). If you plan to travel more often, another option (a so-called "OV-chipkaart") would be cheaper, but more troublesome to arrange. If you like to have information on this option, please refer to www.ov-chipkaart.nl. Note: if you plan to visit Amsterdam or Rotterdam before or after the conference, you will need an OV-chipkaart for the trams and the metro. In this case, please refer to the website above. Information on (bus/train) schedules can be found at www.9292ov.nl/en.

Taxi You can use a so-called "Train-taxi" from Enschede and Hengelo station, which is available starting at 7:00 till 10 minutes after the arrival of the last train. The "Train-taxi" is a shared taxi, which means you might need to wait a bit longer than for regular taxis. You can only use a "Train-taxi" ticket together with your train ticket. A one-way ticket costs € 4.90 at the ticket machine and € 5.50 at the driver.

Other taxi companies in the region are:

Taxiservice	+31 (0)900 8294737
Taxi Hotax Enschede	+31 (0)53 4784789
Taxi Hengelo Black Cab	+31 (0)74 2919717

A taxi ride from the railway stations of Enschede or Hengelo to the campus of the University of Twente costs approximately € 17.

Trains in the Netherlands If you want to travel by train, you can buy a ticket:

- at the yellow self-service ticket machines. Payment can be done by debit card (Maestro) or coins. Unfortunately, not all ticket machines accept credit cards.
- at a service desk at a larger railway station. There is a € 0.50 charge for using this service. Payment is possible by cash or debit card (Maestro), at Schiphol and Amsterdam Central you can also pay by credit card. At Schiphol, Amsterdam Central, Hengelo and Enschede service desks are available.

For trains, payment by OV-chipkaart is also possible, but since the prices per trip are the same as for a paper ticket, this is not recommended for short stays. Information on (bus/train) schedules can be found at www.9292ov.nl/en.

Note: a direct train connection to the campus of the University of Twente is not available. You still need to take a bus or taxi from Hengelo or Enschede (Drienerlo), or walk to the campus from Enschede Drienerlo (15-20 minutes).

Registration Desk Registration is possible during the Welcoming Party on Sunday July 15 (16:00 - 19:00) in the Ravelijn building on campus (Building 10), or between 9:00 and 10:00 on Monday July 16 at the Registration Desk, in the entrance hall of Hall B (Building 13). The registration desk will be staffed during the scientific program in case you have any questions, or need to register late.

Lunches and Refreshment Breaks All lunches are included in the conference fee, and take place in the Foyer on floor 2 of the Waaier (Building 12). Also the coffee breaks take place in the Foyer of the Waaier.

Furthermore, participants can use the student restaurant, located in building the Waaier (Building 12), ground floor. The restaurant is open from 12:00 to 13:30 and from 17:00 to 19:00. Payment in the restaurant can be done by cash. Also there are vending machines in the Waaier (Building 12). Payment at these vending machines, however, is only possible by chip-card. If you don't have a chip-card, please refer to the registration desk or go to the restaurant. Finally, there is a supermarket on campus, which is open from Monday to Friday from 9:00 to 18:00 and on Saturday from 9:00 to 17:00.

Poster Display The poster session is proceeded by a plenary pitch session, in which all presenters have 3 minutes to get the audience interested in their poster. This pitch session takes place on Monday July 16 from 13:00 to 14:00 in Waaier 2. Afterwards, from 14:00 to 15:30 the poster session takes place in the Foyer of the Waaier (building 12). The posters will be displayed in the Waaier until Tuesday afternoon. You can hang your poster on the display location before the start of the program or during the lunch break on Monday. The poster can be collected from this location on Thursday or Friday.

Symposium On Tuesday July 17, we organize a symposium focusing on the implementation of OR models in healthcare. This symposium will run parallel to ORAHS 2012, and all sessions of the symposium are open for ORAHS participants. One of the sessions of the symposium is sponsored by ORTEC and focuses on personnel planning, and the implementation of planning tools in practice. A second session is sponsored by Information Builders, and focuses on the interaction between the operating room and nursing wards. The symposium is included in the program as the fourth parallel track on Tuesday.

Discussion Session On Tuesday following the keynote talk by Prof. Wim van Harten, there will be a plenary discussion session in which academics and practitioners can discuss the applicability of OR models in healthcare practice. Participants from both ORAHS 2012 and the symposium 'Operations Research Applied to Health Service: From Theory to Implementation' take part in the discussion.

Lab Tours Instead of the regular hospital tour on Tuesday, this year we offer a (optional) lab tour of the Experimental Centre for Technical Medicine, a high-tech lab at the University of Twente. This lab includes an Operating Room and Intensive Care Units, Human Patient Simulators, an Experimental Medical Diagnostic Laboratory and rooms with virtual reality simulators for laparoscopic interventions, flexible endoscopy, and endovascular interventions. The lab tours take place on Thursday afternoon (parallel to the parallel sessions). Subscription for

the tour is done at the registration desk on a first-come, first-serve basis (max. 50 participants per tour). Meeting place for the tour is at the registration desk; meeting times are Thursday 13:00 (tour 1) and Thursday 15:00 (tour 2).

Social Program As always the social program during ORAHS is extensive. For details, please refer to page 10.

Internet Access Free Wi-Fi is available to all participants. You will need to collect a username and password from the Registration Desk, or you can use the Eduroam network (if applicable to your own organization). In addition, participants may use the computer rooms (RA 3231/3237) in Ravelijn (Building 10), second floor (open from 8:00 to 18:00). Also for this, you need to collect a username and password from the Registration Desk.

Post Conference Publications A special issue of the Elsevier journal 'Operations Research for Health Care' will be devoted to the ORAHS 2012 conference. More information can be found in the leaflet in the conference bag, and through the ORAHS mailing list. For subscribing to the ORAHS mailing list, go to: https://www.di.unito.it/listserver/info/orahs-list.

Share your ORAHS 2012 Photos We have opened a Picasa Web Album for the photos made during the conference. We encourage you to share your conference photos. Here are the login details:

website:	http://picasaweb.google.com
login:	orahs2012@gmail.com
password:	twente2012

Accompanying Person's Program Accompanying people are welcome to join the scientific delegates for the social program, that among other events includes a whole day excursion on Wednesday. In addition, while the delegates attend the scientific program, their partners, children or friends are invited to join us for very nice day trips. In just four days (Monday to Thursday) we will see: Dutch architecture and remarkable landscapes, Queen's castle and farm lands, cheese and clogs, and the elements that formed our country: wind and water. A smart selection of the most special and characteristic aspects of our culture will be introduced to you during a fun, educational, child-friendly, but most of all, very relaxed partner program. We call it "Superdutchyfantasnatureculturistilicious".

During the Welcome Reception on Sunday, more information will be given to you in form of a special "Superdutchyfantasnatureculturistilicious" - booklet. This booklet is very important as it could also be a key to a special PRIZE! If you have any questions about the partner program, please contact Hana Hans (00 31 622148609).

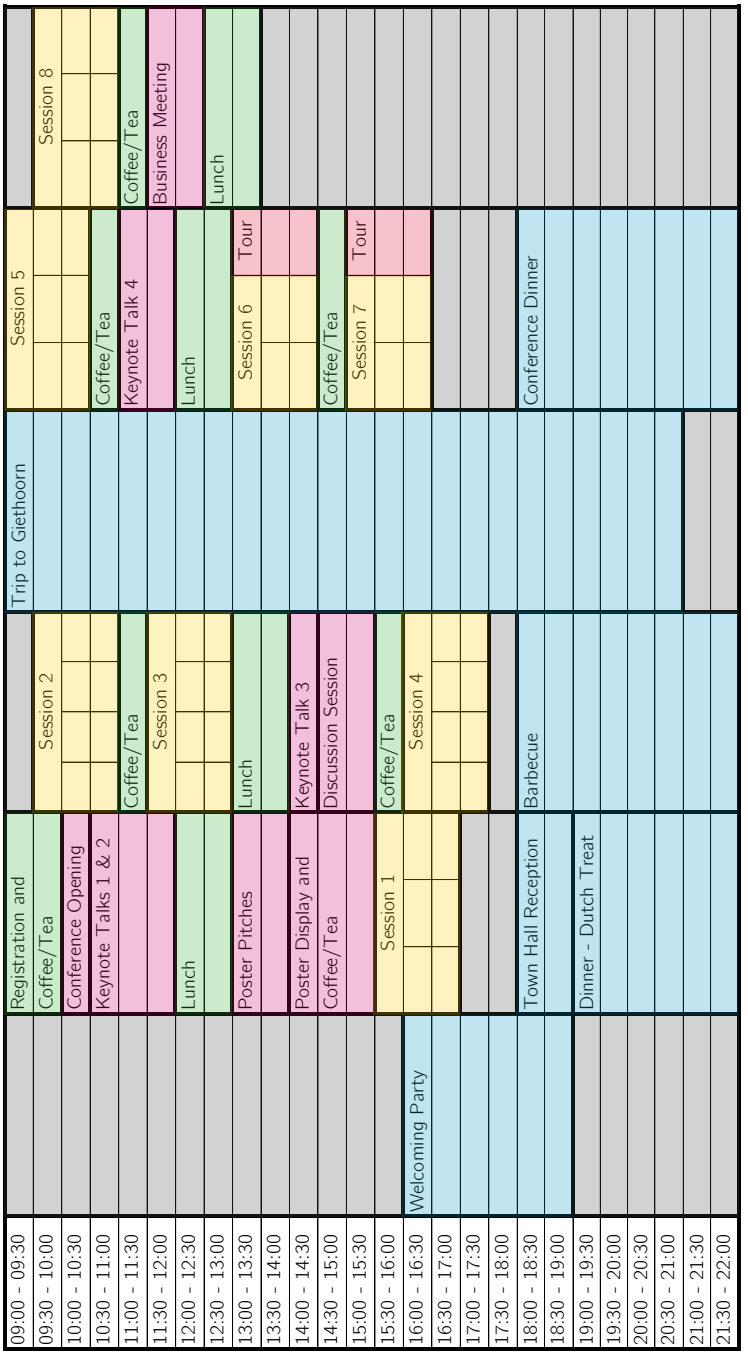
Emergency Contact

National emergency number:	112
Local police:	+ 31 (0) 900 8844
Campus emergency number:	(+31 (0)53 489) 2222
Campus security:	(+31 (0)53 489) 2134

For organizational issues:	
Shirley Kleisen	+31 (0)6 51 69 66 83
Erwin Hans	+31 (0)6 81 47 57 91
Ingrid Vliegen	+31 (0)6 28 99 25 52

Program

Program at a Glance



Social Program

As always, the social program during ORAHS is extensive. Highlights in this year's social program are a trip to Giethoorn, an area called The Venice of Holland, and a conference dinner in restaurant De Jaargetijden, located in the beautiful park Volkspark.

Sunday: Welcoming Party (16:00 - 19:00) Welcoming party in the Ravelijn Building (building 10) at the University of Twente, where you can register for the conference while enjoying drinks and traditional Dutch pancakes.

Monday: Town Hall Reception (18:15 - 19:15) Between 17:45h and 18:00h, buses will collect you at the Drienerburght Hotel (University grounds, building 44) to bring you to the Enschede Town Hall. Here we will provide a tour around the beautiful Town Hall building of Enschede. In 1929 architect Gijsbert Friedhoff won the assignment for designing the Town Hall of Enschede with his design 'In d'oude stad' (In the old city). The building is an example of a 'Gesamtkunstwerk', in which architecture, interior design and art are integrated.

The reception will be held in the Mosaic Room on the second floor of the Town Hall. One wall in this room is decorated with 250,000 little tiles and is designed and made by artists Moulin and Bouhuys from The Hague. After the tour, the mayor of Enschede will officially welcome all delegates to the city of Enschede.

Monday: Dinner - Dutch Treat (19:15 - end) Enjoy a dinner (Dutch treat = pay yourself) in one of the many restaurants in Enschede. See the maps provided at registration and the address list on page 97 for the locations of restaurants. Transportation back to your hotel is not provided.

Tuesday: Barbecue (18:00 - end) Enjoy a barbecue dinner on the university grounds. The barbecue will take place at Boerderij Bosch on the campus of the University of Twente (building 62, near tennis courts). You can only participate if you have registered for the BBQ.

Wednesday: Trip to Giethoorn (9:00 - 21:00) Giethoorn is a small village in the East of The Netherlands. The canals, the uncountable characteristic wooden arch bridges and the little reed covered farm houses and beautiful gardens have given Giethoorn the nickname the Venice of Holland. It became famous, especially after 1958, when the Dutch film maker Bert Haanstra made his famous comedy "Fanfare" there.

At 9:00 a.m. buses will collect you at the Drienerburght Hotel (University grounds, building 44) to bring you to Giethoorn in approximately 2 hours. We will discover Giethoorn by a tour with small boats, go picnicking on a small island and conclude the day with a dinner by the

waterside. All food and transportation is included. In case of a sunny day, bring sun glasses and sun cream!

Thursday: Conference Dinner (18:00 - 22:00) The conference dinner will be served in restaurant De Jaargetijden, located in a beautiful park near Enschede Central Station. Drinks are included. Buses will collect delegates at the Drienerburght Hotel (UT, building 44) at 17:30h and at the Broeierd Hotel at 17:45h. With public transport: take bus 1 from Enschede Central Station and exit at the first stop (Volkspark). Transportation back to your hotel is not included.

Scientific Program

Keynote Speakers

Drs. Pieter Vos Drs. Pieter Vos received his Master degree in Organizational Psychology from the Leiden University in 1977. After holding several functions in healthcare, he started working for the National Public Health Council, for which he became secretary-general in 1994. This council was discontinued in 1996, after which the Council for Public Health and Health Care (Raad voor de Volksgezondheid en Zorg (RVZ)) was formed. The RVZ is an independent body which advises the government on public health and care. Pieter Vos is Secretary-General of the RVZ, a body consisting of approximately 30 employees.

Besides his function at the RVZ, Pieter Vos is a member of several supervision councils and advisory councils in healthcare.

Pieter's fields of expertise are: the healthcare system, mental health care and healthcare for disabled persons, medical specialist care, hospitals and rehabilitation care, and labor and training in the healthcare sector.

Pieter Vos will speak on Monday July 16th, 10:30-11:15. The abstract of his talk can be found on page 17.

Dr. Hanneke Klopper For her Masters in Organisational Psychology Hanneke Klopper studied the manageability of a University Cardiac-care Centre. From literature she derived the importance of organisational culture within professional service organisations on both the manageability and quality performance. After her Masters she worked as an organisational consultant in several hospitals. From August 2002 she was director in the Hospital Group Twente in Almelo, The Netherlands. In April 2011 she found a new challenge and started working for De Rugpoli in Delden, a private clinic specialised in back injuries. Her work inspires her to study the complex relationships and dynamics in healthcare organisations. Therefore she performed a PhD study on the effective cooperation between medical doctors and managers and the influence of this co-operation on hospital quality performance, which resulted in a thesis in 2011. In November 2004 she became an associated researcher at the School of Management and Governance of the University of Twente.

Hanneke Klopper will speak on Monday July 16th, 11:15-12:00. The abstract of her talk can be found on page 17.

Prof. Dr. Wim van Harten After his graduation, Wim H. van Harten spent 7 years as M.D. in tropical medicine. On returning from Cameroon, Africa, he decided to focus on public health and health administration. He obtained a degree in community medicine while working as a chief medical advisor of a major health insurance company (1986-1992). As a chief executive officer in rehabilitation hospital "Het Roessingh" (1992-2001) in Enschede, he finished his Ph.D. on quality management (1997).

In June 2001 he started as a member of the executive board of the National Cancer Institute - Antoni van Leeuwenhoek Hospital (NKI-AVL) in Amsterdam, The Netherlands, where he is responsible for Organisation & Management. He is also a member of the Board of the Dutch Hospital Association.

Since 2001 he is part-time professor on the chair "Quality Management of Health Care Technology" at the department of Health Technology and Services Research of the School of Management and Governance at the University of Twente, The Netherlands.

In 2006 he became a Board member to the OECI, the Organisation of European Cancer Centres, that dedicates itself to improve the quality of cancer care and translational research in Europe. As of June 2011 he became President to the OECI for a period of three years.

Publications of Prof. van Harten are in the field of technology assessment, research into the effects of Quality management, translating operations management and -research techniques into hospital care and cancer survivorship care.

Wim van Harten will speak on Tuesday July 17th, 14:00-14:30. The abstract of his talk can be found on page 53.

Prof. Dr. Vinod Subramaniam Vinod Subramaniam was trained in Electrical Engineering and Applied Physics (Cornell University, Ithaca, New York and University of Michigan, Ann Arbor, Michigan). After receiving his PhD in 1996, he moved to the Max Planck Institute for Biophysical Chemistry in Goettingen, Germany as a postdoctoral fellow in the group of Dr. Thomas M. Jovin. He was awarded an Alexander von Humboldt fellowship and a Human Frontiers Science Program long-term fellowship. He stayed at the Max Planck Institute until 2002 as a staff scientist and group leader. In 2002 he joined the Advanced Science and Technology Laboratory of AstraZeneca in Loughborough, United Kingdom as a senior research scientist. In 2004 he was appointed professor and chair of Biophysical Engineering at the University of Twente. His work has been recognized by the Fluorescence Young Investigator Award of the Biophysical Society.

Since May 1, 2012, Prof. Subramaniam is the scientific director of MIRA, the research institute of Biomedical Technology and Technical Medicine of the University of Twente.

His research interests include understanding the nano- and meso-scale details of protein conformational dynamics, and in particular, the biophysics of protein misfolding and amyloid formation using a broad range of microscopy and spectroscopy techniques.

Vinod Subramaniam will speak on Thursday July 19th, 11:00-11:45. The abstract of his talk can be found on page 69.

Monday July 16th

09:00 Registration and Coffee/Tea *Rooms: Hal B and Foyer Waaier*

10:00 Conference Opening *Room: Waaier 2*

Ed Brinksma, Rector Magnificus of the University of Twente

Erwin Hans and Ingrid Vliegen on behalf of the Organizing Committee of ORAHS 2012

Sally Brailsford, Chair of ORAHS

10:30 Keynote Talks 1 & 2 *Room: Waaier 2*

Pieter Vos (p17) The Dutch healthcare system in 2020: High Tech Human Touch?

Hanneke Klopper (p17) Mind the gap

12:00 Lunch *Room: Foyer Waaier*

13:00 Poster Pitches *Room: Waaier 2*

Nor Aliza Abd Rahmin (p18) Simple heuristics for on-line scheduling of operating theatres

Matthew Adaji (p18) Mathematical model for cost optimization option with priority queueing

Friday Adejoh (p19) Application of queuing model to waiting time of out-patients in public hospitals in Benue state, Nigeria

Nardo Borgman (p19) Organizing acute care: Logistics optimization of an integrated emergency post using discrete event simulation

Martine Breteler (p20) Scenario analysis and real options modeling of home brain monitoring in epilepsy patients

Pornpimol Chaiwuttisak (p20) Location-allocation problem for blood service facility in Thailand

Sarah Dalton (p21) How to predict high dependency cot demand in upcoming days

Angelico Fetta (p21) Modelling adolescent smoking behaviours with social network analysis

Mushota Kabaso (p22) A simulation model of long-term survival estimates and economic costs of antiretroviral therapy (ART) in Zambia

Sarah Kok (p22) Modeling the impact of serosorting on the spread of HIV in men who have sex with men

Joep Kraeima (p23) Optimisation of breast cancer follow-up: Individualising trajectories based on risk stratification

Arturo Pérez Rivera (p23) Radiotherapy capacity planning

Pieter Smet (p24) A comparison of fairness objectives for nurse rostering

Nizar Triki (p24) Planning home health care service

Gerard van der Linde (p25) Simulating the effect of an integrated emergency post: A quantitative comparison of an integrated and a non integrated emergency post by using discrete event simulation

Wim Vancroonenburg (p25) Patient-to-room assignment planning in a dynamic context

Renske Visser (p26) A decision framework for selecting healthcare modeling approaches

Peter Williams (p26) Unpunctuality in outpatient arrivals: Some fresh data

Peter Williams (p27) Capacity modelling of a multi-Level system: Gatekeeper model revisited for chronic illness

14:00 Poster Display and Coffee/Tea *Room: Foyer Waaier*

15:30 Session 1

1A Epidemiology and Disease Modeling *Room: Carré 1A*	**1B Organization of Healthcare Facilities** *Room: Carré 1B*	**1C Interaction between OR and Ward** *Room: Carré 1C*
Alexander Rutherford (p28) A system dynamics model of the continuum of care for HIV/AIDS	**Timo Hartmann (p30)** Save planning of hospital renovations	**Lerzan Ormeci (p32)** Optimal mix of surgical procedures under stochastic patient length of stay

Fredrik Dahl (p28) Modelling population effects on HIV of prophylactic ART medication in Malawi	**Ines Verena Arnolds (p30)** Multi-period ward layout planning for hospitals	**Theresia van Essen (p32)** Improve OR-schedule to reduce number of required beds in the HagaZiekenhuis
Joe Viana (p29) Simulation modeling of age related macular degeneration in the UK	**Lene Berge Holm (p31)** Reorganising the central surgery unit: More focus on teamwork	**Aleida Braaksma (p33)** Hourly bed census predictions for inpatient care services
Muhammad Islam (p29) Nonparametric smoothing of the impact of climate change for some selected diseases: a case study for Greater London	**Sally Brailsford (p31)** Simulation modelling for bipolar disorder	**Nikky Kortbeek (p33)** Flexible nurse staffing based upon hourly bed census predictions

18:15 Town Hall Reception

Keynote Talks 1 & 2 **Room: Waaier 2**

The Dutch healthcare system in 2020: High Tech Human Touch? MON-K1

Pieter Vos (Council for Public Health and Health Care)

Monday Keynote Talk 1 | 10:30 - 11:15 | Waaier 2

Many scientific publications start with the statement that the healthcare system is undergoing many changes. Also, in the Netherlands this is the case. In this talk, Pieter Vos will discuss the changes the Dutch healthcare system is going through and/or should go through, and his opinion about what the system will look like in 2020. According to the The Council for Public Health and Health Care the healthcare system in 2020 should be organized considerably different than today to make it possible to answer the changing health care demand. Care should be concentrated in networks of knowledge and skills with a regional orientation. This means a reordering of the healthcare landscape: decentralization of relatively easy, high frequency care and concentration of the complex and acute care. What is the influence of eHealth and other technological changes on this new situation? And how will the personnel and patient be influenced?

Mind the gap MON-K2

Hanneke Klopper (De Rugpoli)

Monday Keynote Talk 2 | 11:15 - 12:00 | Waaier 2

Hospitals are complex organisations, one of the reasons for this are the many different professionals working together within one organisation. Of these professionals, physicians tend to have a decisive influence on the total hospital organisation (not only on medical issues, also on organisational outcomes such as finances and policy). We have studied the known complex cooperation between physicians and managers with three different methods: culture gaps, stereotypical gaps and the gaps between the level of satisfaction with quality, innovation and cooperation. A new aspect in literature, coming from our study is that we statistically associated the above mentioned gaps between physicians and managers with the hospital performance indicators. The results of our study confirm the existence of the presumed latent conflict between physicians and managers and show that, below the surface of the daily practices, the relationship between (members of) both groups is tense, leading to suboptimal cooperation. This might decrease hospital performance, and could ultimately harm patients. One of the biggest challenges in hospitals is to improve quality of care and patient satisfaction, and simultaneously control costs. The results encourage to focus on improved cooperation between physicians and managers when implementing performance initiatives; effective cooperation between physicians and managers may be one of the key factors to face our challenges.

1 - Simple heuristics for on-line scheduling of operating theatres MON-PS

Nor Aliza Abd Rahmin (University of Southampton)
Chris Potts, Marion Penn

Monday Poster Session | 13:00 - 15:30 | Waaier 2 & Foyer

An Operating theatre is one of the most important and expensive resources in the facilities hospital. Therefore, surgery is a critical process in a hospital, not only for the cost but also for the impact of a patient's health and quality perception. Uncertainty may prevent a previously constructed plan from being executed. Waiting for treatment due to operating theatre unavailability can result in deteriorating health and even worse can lead to death. In this research, we focus on an operating theatre scheduling problem for emergency and regular patients. However, long operation times or a high number of emergency patients arriving can lead to a disruption of previous bookings. We consider an on-line version of this problem where each day a new schedule is created based on current information such as new patients who need to be booked into a slot in the operating theatre and previously scheduled patients whose treatment could not be performed because of operating theatre capacity constraints need to be reebok. We allocate the patients depend on their urgency using a simple heuristic method, updating the schedule every day. Computational results are reported.

2 - Mathematical model for cost optimization option with priority queueing MON-PS

Matthew Adaji (Benue State Polytechnic)
Friday Adejo

Monday Poster Session | 13:00 - 15:30 | Waaier 2 & Foyer

Waiting for service is part of real-life phenomenon as customers queue to receive service. This waiting could be avoided or minimized when priority queuing discipline is used. In this work, we showed that customers are willing to make higher payment in order to minimize delay, thereby minimizing frustration, stress and total cost in queue. We analyzed the allocation of priority in queues via simple bidding mechanisms. In our model, the stochastically arriving customers made bids upon arrivals at a queue whose length was unobservable. By this, customers obtained priority over all customers who were waiting in the queue who made lower bids. We considered a non preemptive priority queue with four priority classes, Poisson arrival processes, exponential service time distributions and established the equations for average waiting time and expected average cost. In particular, we defined a random impatient factor a (0) that measured how much money a customer lost for time spent in queue and posed optimization problem that minimized the total cost. We introduced cost function that was used in the numerical example and found that it is the sum of customers bid and the cost of waiting. We used Excel Package and generated customers arrival (by simulation) placed them in a waiting line depending on their priority class, and selected the next customer to be served by using priority that depends on bidding. The numerical result indicated the bid (N4800) yielded the minimum total cost.

3 - Application of queuing model to waiting time of out-patients in public hospitals in Benue state, Nigeria **MON-PS**

Friday Adejoh (Benue State Polytechnic)
Matthew Adaji

Monday Poster Session | 13:00 - 15:30 | Waaier 2 & Foyer

This paper considers the waiting time of three categories of patients in Federal Medical Centre, Makurdi and General Hospital, Otukpo, Benue State, Nigeria as a single-channel queuing system with Poisson arrivals and exponential service rate where arrivals are handled on a first come first serve basis except for emergency cases where priority queuing discipline is applied. Hence, the m/m/1 queuing system is however applied. The average number of patients per category, the average time spent by each patient as well as the probability of arrival of patients into the queuing system is obtained. The queuing problems encountered at the Federal Medical centre, Makurdi is similar to what is encountered in General Hospital Otukpo and probably applicable to Government Hospitals across the state. The paper concluded that excessive waste of time in the Hospitals or health centres has led to patients' health complications and in some cases, eventual death, which may be avoided.

4 - Organizing acute care: Logistics optimization of an integrated emergency post using discrete event simulation **MON-PS**

Nardo Borgman (University of Twente)
Martijn Mes, Ingrid Vliegen

Monday Poster Session | 13:00 - 15:30 | Waaier 2 & Foyer

In the Netherlands patients with an acute care demand outside office hours visit the emergency department (ED) or general practitioners post (GP post). Many walk-in patients that go to the ED however could be helped more efficiently and cheaper at the GP post. Therefore, in April 2010, the Centrale Huisartsenpost Almelo (GP post Almelo) and the emergency department of Ziekenhuisgroep Twente (hospital in Almelo) merged into one, so-called integrated emergency post. Combining these two care providers resulted in a single access point for patients seeking acute care. This research aims to find the optimal process design of the integrated emergency post where the correct patient is provided with appropriate care, without unnecessary delays and with an optimal use of resources. Using computer simulation and a systematic approach organizational interventions are compared and an optimal integrated emergency post design is sought. This systematic approach uses experimental design and simulation optimization to gain insights into the effects of organizational interventions like alternate staffing levels or dedicating staff and resources to specified patient types. This will give insight in the interventions influence on important performance indicators, such as patient length-of-stay and throughput times. Additionally the generic simulation model design enables the evaluation of promising organizational interventions on other comparable- and non-comparable integrated emergency posts.

5 - Scenario analysis and real options modeling of home brain monitoring in epilepsy patients **MON-PS**

Martine Breteler (University of Twente)
Berend Roorda, Michel van Putten, Janine van Til, Maarten Ijzerman

Monday Poster Session | 13:00 - 15:30 | Waaier 2 & Foyer

Background: A project of the High Tech Health Farm called Long-term in-home EEG monitoring in epilepsy is founded to improve the diagnostic process in epilepsy patients. However, a lot of uncertainties exist and introducing new technologies to the healthcare market is difficult when efficiency and costs are not known yet. To support market access of Home Brain Monitoring (HBM), an early health technology assessment (HTA) approach is required to estimate uncertainty surrounding HBM.

Objective: To construct different implementation scenarios of HBM and to value these scenarios by making use of real options analysis to address uncertainty. This method valuates different scenarios in terms of most beneficial to invest and thereby facilitates investment decisions in future.

Methods: Key uncertainties of HBM are defined and presented to 20 experts by making use of semi-structured interviews. Expert elicitation is used to synthesize beliefs regarding HBM and probabilities of success regarding the key uncertainties of HBM were estimated. Sensitivity analysis is used to demonstrate the impact of uncertainties on the option value of the project.

Results: The elicited judgments show that the probability per scenario is highest for implementing HBM as a substitute for recordings after a first routine EEG.

Conclusion: It is expected that the most promising application scenario will be the implementation of HBM when it can substitute all described current diagnostic paths. The most likely scenario will be the implementation of HBM after ordering a first routine EEG and thereby substituting sleep deprivation or a second EEG.

6 - Location-allocation problem for blood service facility in Thailand **MON-PS**

Pornpimol Chaiwuttisak (University of Southampton)
Honora Smith, Yue Wu

Monday Poster Session | 13:00 - 15:30 | Waaier 2 & Foyer

Decision making on facility locations for blood services has an impact on the efficiency of supply chain and logistics systems. We introduce the current blood supply chain system of Thai Red Cross and the problem faced. At the present time, there is one National Blood Centre (NBC) at the capital and twelve Regional Blood Centres (RBCs) in the provinces to collect, prepare, test, and distribute safe blood. However, the amount of blood collected is still not enough to meet demand. More fixed collection sites are proposed to make easy access for donors. In addition, some sites can perform preparation and storage for blood that hospitals can receive directly. Selecting sites of blood rooms for either blood collection from donors or blood distribution to hospitals is a strategic plan within a limited investment budget of this nonprofit organisation. We present integer programming for a Location-Allocation Problem based on two classical facility location models: the Maximum Covering model and the p-median model.

The two conflicting objectives of the model are to minimise the demand weighted distance to supply blood to hospital and to maximise the quantity of expected donated blood from volunteers. Computational results on a real life case study are reported, of practical importance to a decision maker.

7 - How to predict high dependency cot demand in upcoming days **MON-PS**

Sarah Dalton (University of Westminster)
Salma Chahed, Thierry Chaussalet

Monday Poster Session | 13:00 - 15:30 | Waaier 2 & Foyer

Our study focusses on high dependency cot use in an English local neonatal unit. Using data routinely collected in the Standardised Electronic Neonatal Database (SEND) for 2009-2011, we have developed a model mimicking patient flows to and through high dependency care, the chief node in our system. Although we have to immediately accept all demand for intensive care and special care cases, there is some latitude to control high dependency traffic in regard of repatriations and elective deliveries. Having warning of a certain sustained cot block might permit flexing up of nursing staff in the near future in order to better match demand.

Empirical data on patient transitions and survival curves have extended our understanding. Forecasts can be modified according to the reason for high dependency care for instance respiratory support, intravenous feeding or close observation. Diagnoses such as respiratory distress syndrome, chronic lung disease, suspected nectrotising entero-colitis and neonatal abstinence syndrome are readily available.

Corrected gestation at birth, plurality, abnormally low weight, age in days, census, origin, destination and the past pattern of the system are taken into account. Use is made of probability theory, normal and binomial distributions and mathematical modelling to help us predict the likely future situation and attendant nursing resource demand in upcoming days.

An example scenario is solved and validated, showing the methodology, its shortcomings and applications.

8 - Modelling adolescent smoking behaviours with social network analysis **MON-PS**

Angelico Fetta (Cardiff University)
Paul Harper, Vincent Knight, Janet Williams

Monday Poster Session | 13:00 - 15:30 | Waaier 2 & Foyer

The link prediction problem for social networks has seen a great advance in recent years following a surge in accessible quantifiable data. Literature has highlighted the importance of networks, not just on our social interactions but on our health and wellbeing as a whole. From obesity to happiness, networks can be found to exhibit clustering behaviour that could potentially indicate an underlying influential network structure.

This research aims to investigate the importance of social networks on the health of school children with regard to smoking. Using a selection of the ASSIST [1] data set, comprised of smoking and social network data from schools across the UK, investigation is sought into the evolution of student networks over time in conjunction with smoking uptake/cessation.

Through the use of Agent Based Simulation, armed with prominent link prediction algorithms from past literature, a more accurate representation of the link between social interactions and health is explored. Should this method be successful, it offers the opportunity to greater understand some of the social aspects of health, potentially creating scope to investigate policy and inform decision makers.

[1] - S. Audrey, K. Cordall, L. Moore, D. Cohen, R. Campbell, on behalf of ASSIST (A Stop Smoking in Schools Trial), The development and implementation of a peer-led intervention to prevent smoking among secondary school students using their established social networks Health Education Journal, 63 (2004): 266284

9 - A simulation model of long-term survival estimates and economic costs of antiretroviral therapy (ART) in Zambia **MON-PS**

Mushota Kabaso (University of Southampton)
Christine Currie, Sally Brailsford

Monday Poster Session | 13:00 - 15:30 | Waaier 2 & Foyer

Sub-Saharan Africa was home to an estimated 22.5 million people with living with HIV in 2009 accounting for approximately 68% of the global total (33.3million) with 1.9 million of these people living in Zambia. There is a paucity of information on estimates of long-term survival and economic costs of people on Antiretroviral Therapy (ART). There have been studies undertaken during the last decade to estimate the survival of HIV-infected people on ART. Different methodologies have been employed in the estimation ranging from Mathematical models to a series of different simulation models.

The proposed research will yield long term survival estimates of persons on ART in Zambia by developing a Discrete Event Simulation model. Using attributes gleaned from a patient level electronic database, a profile of clients who commence ART at public health facilities will be developed as the model input. Clients will be allowed to flow through the model changing their health states from the time they enter the model until death. A collective set of such entities will then be studied after running the model to generate estimates of survival for people on ART. Associated economic costs will be calculated based on costing from the public sector standpoint to generate the lifetime economic cost of providing ART to clients in Zambia.

The poster presentation will show details of the methodology, model assumptions and preliminary results of the analysis.

10 - Modeling the impact of serosorting on the spread of HIV in men who have sex with men **MON-PS**

Sarah Kok (Simon Fraser University)
Paul Tupper, Krisztina Vasarhelyi, Alexander Rutherford

Monday Poster Session | 13:00 - 15:30 | Waaier 2 & Foyer

Serosorting is the practice of restricting unprotected sexual contacts to partners of the same HIV serostatus. It is often assumed that serosorting limits the spread of HIV among men who have sex with men (MSM). If this is not the case, then serosorting could potentially contribute to the spread of HIV.

Using both a deterministic and stochastic network model of HIV transmission we studied how serosorting may impact HIV prevalence in MSM. It was determined when serosorting leads to prevalence decreasing towards zero versus prevalence increasing to endemic HIV. To quantify serosorting, we allowed 0-100% of the population to serosort for all acts of unprotected anal intercourse. Individuals who serosort in the stochastic model are restricted by their local network structure.

In the deterministic model, when mean time to diagnosis was less than 3.5 years serosorting decreased HIV prevalence in the model over time, reaching 0% to 20% at equilibrium. If time to diagnosis was longer, serosorting increased equilibrium prevalence, reaching 20-80%. Comparatively, serosorting increased HIV prevalence in the stochastic model only when time to diagnosis was 10 years or longer. Serosorting in the deterministic and stochastic model has the potential to eliminate the epidemic as long as time to diagnosis is less than 3.5 and 7 years, respectively.

Our model suggests that the impact of serosorting is directly linked to time until diagnosis. Therefore, serosorting may be an effective preventive measure at the population level only once a critical time to diagnosis has been achieved.

11 - Optimisation of breast cancer follow-up: Individualising trajectories based on risk stratification **MON-PS**

Joep Kraeima (University of Twente)
Ingrid Vliegen, Sabine Siesling, Maarten IJzerman

Monday Poster Session | 13:00 - 15:30 | Waaier 2 & Foyer

The follow-up of breast cancer patients is only based on guidelines, and hardly on scientific evidence, resulting in a situation where there is no differentiation between different patients. The goal of this study is to individualise the follow-up trajectories using case characteristics.

To create individualisation, first the individual risk on local recurrence (LRR) is determined. The LRR is calculated by a linear regression method, based on data from the Dutch Comprehensive Cancer Centres. For the selection of which case characteristics to include in the LRR calculation a literature study is combined with experts-opinion by means of a questionnaire.

The second part of the study models the effect of changing frequency and duration of follow-up based on the standard intervention (Mammography and physical breast examination). This can be extended to include other intervention types like for instance MRI.

Promising results are expected concerning the relation between costs, workload or budget use and the risk of missing recurrences. Considering several options, it is the treating specialist who can determine what the optimal follow-up trajectory is for a given individual. The product of this study assists in the shared decision making process of the professional and patient, by presenting several options and the corresponding risks of missing recurrences.

12 - Radiotherapy capacity planning **MON-PS**

Arturo Pérez Rivera (University of Twente)
Ingrid Vliegen, Corine van Vliet-Vroegindeweij, Roel de Boer, Wim van Harten

Monday Poster Session | 13:00 - 15:30 | Waaier 2 & Foyer

Worldwide, around half of the patients diagnosed with cancer receive radiation treatment, or radiotherapy, during their care pathway. Independent of whether radiotherapy is given with curative or pain-relieving intent, delays in the start of this treatment significantly deteriorate the quality of the care and the patients wellbeing. Although radiotherapy is given in an outpatient basis, patients must return to the hospital to receive periodical (e.g. daily) sessions of radiation that ensure the tumor is shrank or killed. Furthermore, the linear accelerators used to give these sessions of radiation to the patients have different technical specifications that allow them to treat only some cancer categories. Due to safety regulations, these machines must be inspected periodically to ensure that the positioning and amount of radiation are under control. In this research, we investigate how to ensure that all patients can start radiotherapy promptly, while complying with the large number of constraints that govern the process and treating as much patients as possible. We develop a model that optimizes the planning decisions for (1) treatments of different cancer categories and (2) periodical machine inspections with respect to the access time (time to begin treatment) of patients. A case study is executed at the Netherlands Cancer Institute (NKI-AVL) in Amsterdam, the Netherlands. The results of this case study are used to formulate conclusions about tactical allocation of radiotherapy capacity to cancer categories and also to give recommendations on planning methodologies to the NKI-AVL.

13 - A comparison of fairness objectives for nurse rostering **MON-PS**

Pieter Smet (KAHO Sint-Lieven)
Greet vanden Berghe

Monday Poster Session | 13:00 - 15:30 | Waaier 2 & Foyer

The nurse rostering problem is a well-known, hard combinatorial optimization problem in which nurses are assigned to shifts, subject to a number of administrative, legal and workforce related constraints. Several studies have shown that the nurses job satisfaction is influenced to a large extent by the quality of their rosters. An important but often neglected factor influencing the quality of a roster is its fairness. Fairness, here, is determined by the distribution of soft constraint violations among the individual rosters. In a fair solution, the penalty incurred by soft constraint violations should be balanced among all nurses.

In automated approaches for nurse rostering, solutions are typically evaluated using a weighted sum objective function, in which the number of violations per constraint is multiplied by its weight. This is a straightforward and easy to understand objective, however, it does not guarantee a fair distribution of individual high quality rosters. According to this objective, a good solution can consist of nurses with a lot of soft constraint violations, who are then compensated in the overall solution quality by nurses with only few violations.

New fairness measures for the nurse rostering problem are presented, in which, implicitly or explicitly, emphasis is put on the worst individual roster. These measures are incorporated into new objective functions for the nurse rostering problem. Experiments are conducted on both benchmark instances from literature and real world instances, illustrating the effectiveness of the proposed objectives.

14 - Planning home health care service **MON-PS**

Nizar Triki (LIMOS - École des Mines de Saint-Étienne)
Thierry Garaix, Xiaolan Xie

Monday Poster Session | 13:00 - 15:30 | Waaier 2 & Foyer

We address the nurse activity planning problem in the home health care service. In many home health care companies (HHCC), this plan comes out at the beginning of each week, during a team-meeting where current patients status and new patients admissions are discussed. Thus, nurses activities are generated according to the individual therapeutic projects of the patients . They must satisfy many operational constraints on: (i) tasks requirements on service time and skills of nurses, (ii) working conditions for nurses: workload, idle times, lunch break, departure and arrival places. In this work, we focus on the underlaying daily optimization problem. Because of perturbations (unavailabilities of patients or nurses), the weekly plan has to be adjusted each day. Many constraints (visiting times, nurses workloads) are tightly defined, and visiting all the patients can therefore be infeasible. Thus, find out practicable solutions can require several iterations of the optimization algorithm with different settings. Modifications of settings (maximal workload, lunch break durations, departure locations, etc...) can be done automatically and/or manually by the decision maker. We formulate the daily nurse routing problem has a multi-depot vehicle routing problem with time windows, profits (when patients are visited) and heterogeneous fleet. This model is general and can handle many variants of our problem. We propose an integer linear program and a list algorithm to solve this problem. Now, in collaboration with two French HHCC, we consider the weekly problem and try to improve reliability in the service using historical data.

15 - Simulating the effect of an integrated emergency post: A quantitative comparison of an integrated and a non integrated emergency post by using discrete event simulation **MON-PS**

Gerard van der Linde (University of Twente)
Ingrid Vliegen, Martijn Mes

Monday Poster Session | 13:00 - 15:30 | Waaier 2 & Foyer

In April 2010, the Integrated Emergency Post (IEP) in Almelo was opened as a result of the collaboration between the ED of the hospital ZGT at Almelo and the GP Post Almelo. This means that for the patient there is one entrance for acute care after office hours. This integration is made on the assumptions that patient friendliness will be improved and organizational overlap will be reduced. However, these two assumptions where based on intuitive feelings. The goal of this project is to achieve a quantitative comparison of the situation before and after realization of the IEP. For this comparison we use discrete event simulation. Not only we want to give an answer about whether it is beneficial to integrate the GP post and the ED in Almelo, we also want to answer this question for GP posts and EDs in other settings, i.e., larger/smaller service areas and other collaborative forms between the ED and the GP post. These questions will be answered to create a generic approach for the acute care in the Netherlands.

16 - Patient-to-room assignment planning in a dynamic context **MON-PS**

Wim Vancroonenburg (KAHO Sint-Lieven)
Patrick de Causmaecker, Frits Spieksma, Greet vanden Berghe

Monday Poster Session | 13:00 - 15:30 | Waaier 2 & Foyer

Within any hospital, a large variety of rooms exists in terms of capacity and equipment, allotted to different medical specialisms. Admitting patients to such a variety of rooms can be challenging. Admission offices aim at finding an assignment of patients to rooms striking a balance between patients' preferences and comfort on the one hand, and patients' clinical conditions and the resulting required room facilities on the other. Both the availability of rooms and equipment, and hospital policies and standards need to be considered, making it difficult to generate balanced patient-to-room assignments. Uncertainty on how long patients will stay in the hospital and when new patients will arrive, may further complicate the situation.

The present contribution defines an online formulation for this dynamic patient assignment (PA) planning problem. Two ILP-models are developed for optimizing this day- to- day planning problem. The first considers finding the optimal assignment for newly arrived patients, whereas the second equally considers future, but planned, arrivals. The performance of both models is compared on a set of benchmark instances. The relative performance with respect to a known lower bound is also presented. The effect of uncertainty on the patients' length of stay is studied, as well as the effect of the percentage of emergency patients. The results show that the second model provides better results under all conditions, while still being computationally tractable.

17 - A decision framework for selecting healthcare modeling approaches **MON-PS**

Renske Visser (University of Twente / The Netherlands Cancer Institute - Antoni van Leeuwenhoek Hospital)
Erwin Hans, Ingrid Vliegen, Wim van Harten

Monday Poster Session | 13:00 - 15:30 | Waaier 2 & Foyer

Operation Research models have been applied to a range of healthcare problems since the 1960s (S. Brailford, 2005). However, healthcare organizations seem to experience difficulties in using the available OR models in their specific situations (W.A.M. van Lent, 2011). One of the problems organizations encounter is how to determine which modeling approach is most suitable to apply to a specific logistic healthcare problem.

The objective of this research is to develop a decision framework to help decide which modeling approach to use for what type of problems. Our approach is as follows. We first classify the available OR models and determine their distinguishing characteristics. We categorize the problems that arise in healthcare based on certain variables, such as organization level (strategic, tactical or operational), number and type of departments/functions involved, nature and amount of variability (for example caused by emergency patients), and the time horizon of the problem. By performing a literature study on case studies in which OR models are used, we identify how to match problem characteristics to modeling approaches. From this we derive a decision framework that will be validated and used in practice for choosing the most suitable model type for modeling situations from a case study at the Antoni van Leeuwenhoek hospital in Amsterdam.

18 - Unpunctuality in outpatient arrivals: Some fresh data **MON-PS**

Peter Williams (University of Limerick)
Brian McKeon, Guangfu Tai, Cathal Heavey

Monday Poster Session | 13:00 - 15:30 | Waaier 2 & Foyer

In modelling on-the-day outpatient department performance, especially as regards patient progress through the system, patients are by default assumed to arrive punctually as scheduled. However, several studies use field data on actual unpunctuality, and in a recent paper co-written by two of the authors (Tai/Williams) a degree of commonality was established in the descriptive statistics. The data used ranged in age from the 1950s to the 2000s, but commonly the recording periods were short, and numbers small.

This work reports data from over 6000 current records taken from a hospital outpatient department information system, which indicates a similar form of frequency distribution. As per the earlier paper, this data presents as peaked, and more so than represented by families of distribution those offered by industry standard software. Of established distributions, the Pearson VII distribution is shown to provide a good match to this, as well as prior data. The respective outpatient department uses a simple interval scheduling system, and the records additionally indicate a degree of diurnal variation which is also analysed. The significance of this is being examined through discrete-event simulation with a view to adjusting work practices in collaboration with relevant parties including patients, clinicians, nursing and scheduling staff.

19 - Capacity modelling of a multi-Level system: Gatekeeper model revisited for chronic illness **MON-PS**

Peter Williams (University of Limerick)
Guangfu Tai

Monday Poster Session | 13:00 - 15:30 | Waaier 2 & Foyer

With the international developmental thrust to push more healthcare work from hospital to ambulatory settings as rooted in the 1978 Alma Ata declaration, and with the increased proportion of chronic disorder maintenance as opposed to curative care, patient trajectories increasingly involve crossing multiple modality levels, involving primary, secondary, tertiary, and continuing/community care.

A question arises as to how to plan for capacity and relate this to consequences for the lives of patients with chronic conditions, especially downtime, and for the consumption of resources in the healthcare delivery system. Chronic illness such as asthma or diabetes involves a degree of self-management, the on-going attentions of primary care providers, and hospitalisation when things go wrong.

A conceptual model, building on an earlier paper presented at an earlier ORAHS meeting (St Etienne) is presented here that incorporates Goldberg and Huxleys Gatekeeper model. A brief review of gatekeeping processes are described based in the extant literature, and it is attempted to differentiate pejorative from functional interpretations. Results from a simulation model are presented. A question arises as to how to usefully model navigational aspects of patient interaction.

1 - A system dynamics model of the continuum of care for HIV/AIDS MON-1A

Alexander Rutherford (Simon Fraser University)
Sarah Kok, Rolando Barrios, Reka Gustafson, Krisztina Vasarhelyi

Monday 1A | 15:30 - 17:00 | Carré 1A

The continuum of care for HIV/AIDS involves public health, primary care, and acute care. The public health system is responsible for diagnosing new HIV cases. Newly diagnosed patients receive a clinical assessment from their primary care physician and usually a referral to an HIV/AIDS specialist. Patients are monitored until they meet the clinical guidelines to start treatment with highly active retroviral therapy (HAART). Once a patient begins HAART, effective followup is important to ensure optimal adherence to therapy. HAART significantly reduces acuity by maintaining the patient's CD4 count at normal levels and effectively eliminates infectiousness by reducing viral load to undetectable.

Engagement of patients in therapy and effective adherence reduces HIV incidence, because these patients are not infectious. This feedback loop reduces the load of the HIV epidemic on the public health system. Furthermore, reduced acuity for patients treated with HAART lowers the demand for acute care due to AIDS and HIV comorbidities. The potential saving in acute care resources per patient is significant, because AIDS patients often require treatment in the intensive care unit. We model the relationship between these different components of the HIV/AIDS continuum of care. A unified modelling language activity diagram is developed by interviewing public health experts and HIV/AIDS clinicians. This diagram is used to build a system dynamics model for optimising the allocation of resources to achieve the maximum reduction in HIV incidence. We also examine potential changes to treatment guidelines and proposals for improving adherence to therapy.

2 - Modelling population effects on HIV of prophylactic ART medication in Malawi MON-1A

Fredrik Dahl (Akershus University Hospital)

Monday 1A | 15:30 - 17:00 | Carré 1A

We give a prediction model for how prophylactic use of anti retroviral treatment (ART) can reduce the HIV epidemic in Malawi, Africa. We analyze the strategy of giving ART to uninfected people, which makes it possible to define credible population level models of infectiousness, without the detailed modelling of disease staging and timing of treatment. As a baseline starting point of our model we use a newly published model of HIV incidence in Malawi, which relies on steady state assumption without ART. We combine this with preliminary results from an RCT, which studies the effectiveness of prophylactic ART. Our model can be used to compute estimates for how population wide ART prophylaxis may change HIV prevalence and incidence over a 50 year period.

3 - Simulation modeling of age related macular degeneration in the UK **MON-1A**

Joe Viana (University of Southampton)
Andrew Channon, Stuart Rossiter, Sally Brailsford, Andrew Lotery

Monday 1A | 15:30 - 17:00 | Carré 1A

Age-Related Macular Degeneration (ARMD) is one of the major causes of sight loss amongst the elderly. There are two types of ARMD: dry and wet, the latter of which can be managed by monthly injections into the eye. The frequency of treatment for wet ARMD, combined with increase in patients, due to the UKs ageing population has resulted in increased demand on Ophthalmology departments (OD). Modeling the ophthalmology department in Southampton at 3 different levels, is part of the Care Life Cycle (CLC) project a multidisciplinary project involving operational research, gerontology, complexity science, demography and social statistics; which explores the links between health and social care in the UK. A Discrete Event Simulation (DES) model of an OD has been produced to evaluate alternative clinic configurations, in terms of the number of patients who can be seen, the effect on waiting time and length of stay. The DES model has been combined with an Agent Based (AB) model, which captures the social care need(s) of individuals as well as the degree to which those needs are being met. Each agents level of sight is captured by an individual System Dynamics (SD) model of each eye. The AB model and the embedded SD model incorporate not only the natural changes in level of social care need and sight loss associated with age, but also the specific impact of ARMD. The purpose of the combined models is to explore how social care and health care interact, using ARMD as a case study.

4 - Nonparametric smoothing of the impact of climate change for some selected diseases: a case study for Greater London **MON-1A**

Muhammad Islam (University of Westminster)
Thierry Chaussalet, Nazmiye Ozkan, Eren Demir

Monday 1A | 15:30 - 17:00 | Carré 1A

The analysis of observational epidemiology is often restricted to the assumption that the factors are linearly associated without any prior empirical or theoretical reasons. This is also true for the complex relationships of climate change and health. Literature reviews revealed that population with a temperate climate generally shows non-linear U, V, N shaped relationships. We aim to examine the nonlinear relationships between daily emergency hospital admissions for elderly people due to some selected diseases (e.g., COPD, asthma) and climate variables (temperature, humidity, pressure, rainfall, and wind speed) in greater London, UK. Nonparametric smoothing in general and generalized additive model in particular, represents an attractive approach for dealing such research question. The response variable will be the daily number of elderly hospital admissions which is expected to vary as a non-linear function of these meteorological variables. Hospital Episodes Statistics for the patients 65 years or more and Met office observational data from weather stations (London) for 2005-2010 will be used. Thus we will have the opportunity to capture the appropriate disease-exposure relationships by employing optimized smoothing techniques and uncovering the nonlinear covariate effects. Eventually this will help to measure the sudden fluctuations of these climate factors on emergency elderly admissions due to these selected diseases in a more realistic approach. This will promote the decision makers to understand the complex picture of climate change and disease exposures precisely and thereby help predict the patient flow and demand of care under changing climate consequences.

1 - Save planning of hospital renovations **MON-1B**

Timo Hartmann (University of Twente)

Monday 1B | 15:30 - 17:00 | Carré 1B

Renovation activities in hospitals often result in infections, fires, budget overruns, and construction delays. Therefore, construction and renovation activities in health-care facilities require substantial planning and coordination to minimize the risks both during projects, and after their completion (Sehulster, et al., 2003). During such planning and coordination activities, project teams have to carefully consider, which impacts construction activities have on hospital operations and safety. Formal methods to better plan for hospital renovation activities are required to ensure the save and cost efficient transformation of hospitals. At the conference, three of these methods will be presented using the case of a small hospital renovation in the Netherlands: The development and optimization of critical path schedules with formal network scheduling and optimization methods, resource balancing and leveling using line of balance scheduling methods, and construction schedule visualization methods (so called 4D planning).

2 - Multi-period ward layout planning for hospitals **MON-1B**

Ines Verena Arnolds (Karlsruhe Institute of Technology)
Stefan Nickel

Monday 1B | 15:30 - 17:00 | Carré 1B

The spatial organization within hospitals directly influences the quality and effectiveness of healthcare services. Hospital buildings are commonly planned in a long-term perspective, which results in static ward layouts. But, medical and organizational factors influencing daily operations change over time. An example is the demand for different-sized bedrooms which varies because of medical implications and patient preferences. Due to this volatility of demand, a static ward layout may not reflect the need for different-sized bedrooms. Hence, we focus on planning adaptable ward layouts over multiple periods. We develop two models, a binary (BLP) and an integer linear program (ILP). Both models allow for layout adaptations during the planning horizon. The aim is to minimize the costs to install and move walls while satisfying demand for different room sizes. In an earlier work, we have presented a sensitivity analysis approach to derive in which settings the costs for adapting a layout do not exceed the benefits of such a change. Now, computational experiments using a standard solver (IBM ILOG CPLEX 12.2) are presented to compare the two models. We solve randomly generated instances. We test the eect of different parameter values for the number of periods, rooms, amount of room types, and costs. The results show that for realistic instances the BLP performs better with respect to the solution time. In some instances no solution could be proved optimal in a given time. In these cases the BLP also outperformed the ILP regarding the objective function values of feasible solutions found.

3 - Reorganising the central surgery unit: More focus on teamwork **MON-1B**

Lene Berge Holm (Akershus University Hospital)

Monday 1B | 15:30 - 17:00 | Carré 1B

In 2011 Akershus University Hospital increased its catchment area with 45% due to a restructuring of the hospital districts of the greater metropolitan area of Oslo. The Central Surgery Unit (CSU) prepared for this by initiating a project to evaluate potential operational improvement of the unit. The main results from this project, which used a combination of Soft Systems Methodology and Discrete Event Simulation, showed suboptimal communication and team behaviour among operating theatre personnel. Literature shows us that that improved teamwork in surgical theatres is associated with increased patient safety and fewer complications, increased efficiency and better work environment. This, in combination with the results from the first project, initiated a new project at CSU where team behaviour was essential. In this project a large project group has worked with creating new guidelines which facilitated better cooperation and team behaviour. These guidelines have just been implemented. This soft operational research project will evaluate to which extend the new guidelines are followed and if it actually facilitates better communication and team behaviour. Thereafter, the aim is to evaluate the effect of the guidelines on a number of outcome measures, such as number of procedures per time unit, start time of first procedure per day, turnaround time, preparation time, knife time, number of pre-surgical errors, and more. Introducing team thinking at a surgical unit is challenging. It requires a high degree of loyalty to the decisions made, and involves a cultural change which is challenging in a large hospital.

4 - Simulation modelling for bipolar disorder **MON-1B**

Sally Brailsford (University of Southampton)
Syed Mohiuddin

Monday 1B | 15:30 - 17:00 | Carré 1B

This paper describes the role of mathematical modelling in the design and evaluation of an automated system of wearable and environmental sensors called PAM (Personalised Ambient Monitoring), to monitor the activity patterns of patients with bipolar disorder (BD). The modelling work was part of a multi-disciplinary project also involving biomedical engineers and computer scientists, to develop a prototype PAM system. BD is a chronic, disabling mental illness associated with recurrent severe episodes of mania and depression, interspersed with periods of remission. Early detection of the onset of an acute episode is crucial for effective treatment and control. The aim of PAM is to enable patients with BD to self-manage their condition, by identifying the persons normal activity signature and thus automatically detecting tiny changes in behaviour patterns which could herald the possible onset of an acute episode. PAM then alerts the patient to take appropriate action in time to prevent further deterioration and possible hospitalisation. A stochastic disease state transition model for BD was used for a Monte Carlo simulation to test a wide range of monitoring scenarios. The minimum best set of sensors suitable to detect the onset of acute episodes (of both mania and depression) is identified, and the performance of the PAM system evaluated for a range of personalised choices of sensors.

1 - Optimal mix of surgical procedures under stochastic patient length of stay MON-1C

Lerzan Ormeci (Koc University)
Hessam Bavafa, Sergei Savin

Monday 1C | 15:30 - 17:00 | Carré 1C

In this study we provide analytical insights on how to optimally allocate hospital operating capacity between various types of elective surgical procedures. Our focus is on the interaction between utilizing hospital beds and operating room capacity, which are the major constraining resources. In our model, each procedure type has an associated revenue, deterministic case duration, and stochastic length of stay, which is the time it takes for patients to recover and leave the hospital; we consider arbitrary distributions for length of stay in this paper. The surgeries performed today affect the availability of hospital beds for the following days in this setting. We describe the optimal mix of procedures in the presence of a service-level constraint on hospital beds, an operating room capacity constraint, and procedure demand constraints.

2 - Improve OR-schedule to reduce number of required beds in the HagaZiekenhuis MON-1C

Theresia van Essen (University of Twente / HagaZiekenhuis)
Joël Bosch, Erwin Hans, Mark van Houdenhoven, Johann Hurink

Monday 1C | 15:30 - 17:00 | Carré 1C

After surgery most of the surgical patients have to be admitted and treated at one of the wards in the hospital. Due to financial reasons, but also because the number of available nurses in the Netherlands is decreasing over the years, it is important to reduce the number of required beds as much as possible. One possible way to achieve this is to create an operating room (OR) schedule that spreads the usage of beds nicely over time, and thereby, minimizes the number of required beds.

An OR-schedule is given by an assignment of OR-blocks to specific days and ORs in the planning horizon, where OR-blocks are defined as a combination of several surgery types, which have to be performed by one surgeon. An OR-schedule has to fulfill a number of resource constraints, and leads to a number of required beds. Due to the stochastic nature of the length of stay of patients, the analytical calculation of this number results in a complex formulation which involves convolutions of discrete distributions.

We present two different approaches to deal with this complexity. First, a heuristic approach based on local search is given, which takes into account the detailed formulation of the objective. A second approach reduces the complexity by simplifying the objective function. Since the HagaZiekenhuis in the Netherlands originated this project, the two approaches are tested on data of this hospital. The computational results are compared to determine which method provides a better solution to the problem.

3 - Hourly bed census predictions for inpatient care services MON-1C

Aleida Braaksma (Academic Medical Center Amsterdam / University of Twente)
Nikky Kortbeek, Ferry Smeenk, Piet Bakker, Richard Boucherie

Monday 1C | 15:30 - 17:00 | Carré 1C

Societal developments demand hospitals to increase quality of care, while on the other hand improved logistical efficiency is required. This entails a strong incentive to reconsider the design and operations of inpatient care services, where quantitative modeling can be of great help. Effectively designing inpatient care services requires simultaneous consideration of several interrelated strategic and tactical planning issues. Given service and case mix decisions, hospital management has to decide upon care unit partitioning and care unit size. The inpatient care facility is a downstream department of which the workload is mainly determined by the upstream departments, namely the operating theater and the emergency department.

We present a stochastic analytical model that predicts the hourly bed census on nursing wards as a function of the Master Surgical Schedule (MSS) and a cyclic arrival pattern of emergency patients. Using this model, changes to both the design and the operations of inpatient care units can be evaluated.

We demonstrate the effectiveness of our model by applying it to a case study of the surgical inpatient clinic within the Academic Medical Center (AMC) Amsterdam. Next to reconsidering the design of these wards by evaluating different configurations for care unit partitioning and care unit sizes, we reconsider the operations on these wards by evaluating changes to the admission and discharge processes. During the upcoming years the presented method will be applied in the AMC in supporting the intended complete redesign of the inpatient care facility.

4 - Flexible nurse staffing based upon hourly bed census predictions MON-1C

Nikky Kortbeek (University of Twente / Academic Medical Center Amsterdam)
Aleida Braaksma, Christian Burger, Richard Boucherie

Monday 1C | 15:30 - 17:00 | Carré 1C

Workload on nursing wards depends highly on patient arrivals and patient lengths of stay, which are both inherently variable. Predicting this workload, and staffing nurses accordingly, is essential for guaranteeing quality of care in a cost effective manner. The previous talk (Hourly bed census predictions for inpatient care services - Aleida Braaksma) presented a method to predict the hourly census in various wards of an inpatient clinic. The current talk introduces a method which uses these hourly census predictions to derive efficient nurse staffing policies. The generic analytic approach minimizes staffing levels while satisfying so-called patient-to-nurse ratios. These ratios prescribe how many patients a nurse can take care of so that patient safety is guaranteed and nurse workload is acceptable. In particular, we explore the potential of flexible staffing policies which allow hospitals to dynamically respond to their fluctuating patient population. In this case, it is only at the start of a work shift that it is decided to which specific care units float nurses are assigned. The method is applied to a case study of the surgical inpatient clinic within the Academic Medical Center (AMC) Amsterdam. Inspired by the numerical results, the AMC decided that this flexible nurse staffing method will be fully implemented. It will be a key-factor in reorganizing the inpatient care services during the upcoming years.

Tuesday July 17th

09:30 Session 2

2A Empirical Modeling in Healthcare	2B Patient Flow (1)	2C Operating Room Planning and Scheduling (1)	2D Practical Challenges in Healthcare
Room: Carré 1A	*Room: Carré 1B*	*Room: Carré 1D*	*Room: Carré 1C*
Steffen Bayer (p38) Length of stay for stroke patients: Statistical and simulation analysis	**Nelly Litvak (p40)** Patient flow analysis	**Andreas Fügener (p42)** Behavioral aspects of operating room planning	**Daniëlle Ekkel (p44)** Simulation based optimization of the operating theatre program
Evin Uzun Jacobson (p38) Causes of delays in hyper-acute stroke care	**Izabela Komenda (p40)** A model of CCU activities through queueing theory	**Inês Marques (p42)** Planning elective surgeries in a Portuguese hospital using a genetic heuristic	**Brecht Cardoen (p44)** Grouping of medical disposable items into custom packs: A mathematical programming approach
Jeroen Beliën (p39) Factors causing non-surgical time in a parallel surgery and anaesthesiology setting	**Jonathan Helm (p41)** Discharge planning to mitigate hospital congestion and bed block	**Sebastian Rachuba (p43)** A robust approach for scheduling in healthcare considering multiple objectives	**Michel Kats (p44)** Tactical planning in ZGT Almelo/Hengelo
Hassan Baalbaki (p39) Fitting multiple distributions in multiple risks situations: Impact on health economic evaluations	**Kiok Liang Teow (p41)** Systems dynamics modelling for specialist outpatient flow	**Fabrício Sperandio (p43)** Optimization via simulation: An approach to the operating room scheduling problem	**Maartje Zonderland (p45)** Variations in the patient care process at the emergency department: Development and implications of an observational instrument

11:00 Coffee/Tea *Room: Foyer Waaier*

11:30 Session 3

3A Healthcare Policy Modeling (1)	3B Patient Flow (2)	3C Home Care	3D Interaction between OR and Ward: From Theory to Practice
Room: Carré 1A	*Room: Carré 1B*	*Room: Carré 1D*	*Room: Carré 1C*
Penelope Mullen (p46) Are numbers still killing people: And what is being done about it?	**Paolo Tubertini (p48)** Health planning via discrete event simulation: A breast screening case study	**Thierry Garaix (p50)** Consistent home health care service	**Peter Vanberkel (p52)** Implementing algorithms to reduce ward occupancy fluctuation through advanced planning

	Leonid Churilov (p46) Can minutes really save years? Simulation modelling for understanding the effect of fast and appropriate access to stroke thrombolysis on functional outcomes and long-term stroke burden	**Sylvia Elkhuizen (p48)** An operational model for comparison of health services for diabetes II between six countries	**Ettore Lanzarone (p50)** A robust programming model for the assignment problem in home care services	**Edgar de Groot (p52)** Linking the OR block plan with bed utilization: From model to implementation
	Abdur Rais (p47) New insights on integer-programming models for the kidney exchange problem	**Yasar Ozcan (p49)** Assessing the impact of organizational changes in clinical pathways	**Bushra Bashir (p51)** The nurse-patient assignment problem in home care	**Renske Visser (p52)** A model to reduce ward occupancy fluctuation through advanced planning: From theory to practice
	Msugh Moses Kembe (p47) Combining high tech with human touch by doctors at Federal Medical Centre Makurdi	**Bernadetta Addis (p49)** Clinical pathways: Insights from a multidisciplinary literature survey	**Hanane Allaoua (p51)** Combining routing and rostering for the home health care problem	**Bernd van den Akker (p52)** Using operation research in real life hospital capacity management
13:00	Lunch			*Room: Foyer Waaier*
14:00	Keynote Talk 3			*Room: Waaier 2*
	Wim van Harten (p53) Translating operations research methods into hospital practice; evidence base and factors influencing optimal use			
14:30	Discussion Session			*Room: Waaier 2*
	A panel consisting of both academics and practitioners (p53) Applying OR models in healthcare practice: Is there need for more advanced models?			
15:30	Coffee/Tea			*Room: Foyer Waaier*
16:00	Session 4			
	4A Healthcare Policy Modeling (2)	**4B Stochastic Modeling (1)**	**4C Operating Room Planning and Scheduling (2)**	**4D Implementing Scheduling Budgets: From Theory to Practice**
	Room: Carré 1A	*Room: Carré 1B*	*Room: Carré 1D*	*Room: Carré 1C*
	Marion Rauner (p54) Prevention programs for occupational injuries: Cost analysis and targeted resource allocation	**Adele Marshall (p56)** Discrete conditional phase-type models for representing patient activity in accident and emergency	**Sara Ceschia (p58)** Patient admission scheduling with operating room constraints	**Egbert van der Veen (p60)** Optimal staffing under annualized hours

Tracey England (p54) Demonstrating the benefit of OR in maximising the use of existing health related data for the Welsh Government	**Dawid Kozlowski (p56)** Use of queue modelling in the analysis of elective patient treatment governed by a maximum waiting time policy	**Guoxuan Ma (p58)** Case mix and capacity planning: An application in a Belgian hospital	**Martin Woudstra (p60)** Controlling workforce scheduling budgets using decision support
Michael Carter (p55) Crossing the OR-policy gap: System dynamics of cross-sector patient flows	**Greggory Schell (p57)** Optimal treatment policies for risk-averse patients with limited resources	**Manisha Rathi (p58)** Predicting hospital resource utilization: A fuzzy regression approach	**Paul Trossèl (p60)** Implementing workforce scheduling budgets: A case study
Teresa Cipriano Rodrigues (p55) Cognitive maps in healthcare: An analysis of reported applications	**Shirin Geranmayeh (p57)** Bed allocation using a generic Markov model	**Luiz Guilherme Nadal Nunes (p59)** Analyzing the use of hospital resources: Applying mathematical programming	

18:00 Barbecue (if registered)

1 - Length of stay for stroke patients: Statistical and simulation analysis TUE-2A

Steffen Bayer (Imperial College Business School)
Evin Uzun Jacobson, James Barlow

Tuesday 2A | 09:30 - 11:00 | Carré 1A

We have analysed the length of stay for stroke patients in Scotland. Based on the analysis of a large data set which covers all stroke patients in Scotland (the Scottish Stroke Care Audit - SSCA), we investigated the factors that influence length of stay and explored scenarios of different policy options using discrete event simulation.

A considerable variation between hospitals as well as a reduction in the LOS of stay for stroke patients which can be observed for stroke patients over the last 5 years, particularly in hospitals which were previously having long LOS can be observed. Our statistical analysis shows that a reduction in the pre-stroke unit length of stay (Pre-SU LOS), that is, how fast a patient is admitted to a stroke unit where he or she can receive specialized stroke care explains to a large extent the reduction in overall LOS.

The simulation analysis considers in addition to LOS of stay performance measures such as thrombolysis rates, average door to needle times, time to admission to specialized care (stroke unit), the average percentage of time spent in stroke unit in order to develop policies which improve overall performance while reducing length of stay. ARENA simulation software is used for modelling and output analysis.

2 - Causes of delays in hyper-acute stroke care TUE-2A

Evin Uzun Jacobson (Imperial College Business School)
Steffen Bayer, James Barlow

Tuesday 2A | 09:30 - 11:00 | Carré 1A

Stroke care delivery is time-critical because urgent imaging of the brain is required in order to identify the patients eligible for thrombolysis which can only be given within a short period after the stroke. The analysis aims to develop a better understanding of hospital delays leading to delayed scanning and diagnosis. We examine both the factors influencing the overall tPA rate as well as the door to needle time. We have analysed the Scottish Stroke Care Audit (SSCA) data that covers all stroke patients in Scotland. A significant relationship exists between delays in the patient pathway and patient characteristics.

We perform a multilevel regression analysis on hospital admission to brain scan times that controls for the case mix and hospital effects (which includes the organisation of hyper-acute stroke care) as well as other patient and hospital level factors such as the thrombolysis rate and the stroke unit bed utilization rate of the admitting hospital and whether the patient arrives within 4 hours of the onset of stroke and within regular work hours.

Among hospitals there are significant differences. Some hospitals (admitting about a quarter of patients) scan at least 80% of those patients arriving within one hour of the onset of stroke that fast enough to be considered for thrombolysis while other hospitals (also admitting about a quarter of patients) manage to achieve this only for about 40% of patients. Hence, if the rest of hospitals perform similarly to the best performing hospitals a significant improvement would already be achieved.

3 - Factors causing non-surgical time in a parallel surgery and anaesthesiology setting **TUE-2A**

Jeroen Beliën (Hogeschool-Universiteit Brussel)
Liesje de Boeck, Jan Colpaert, Michel Meulders, Annabel Sels, Jan Mulier

Tuesday 2A | 09:30 - 11:00 | Carré 1A

Operating room efficiency can be measured in terms of non-surgical time, i.e. the time between the finishing of a surgery and the start of the incision of the next patient. The induction process often represents an important part of this non-surgical time. Even in a parallel setting, in which a succeeding patient is already induced in a separate induction room before the preceding patient has left the operating room, non-surgical time can still occur due to poor patient sequencing. By analyzing 18000 records of surgeries performed in the AZ Sint-Jan Hospital (Belgium), we identify the main factors explaining a patient to cause non-surgical time in a parallel induction surgery setting. We relate our findings to the concept of artificial variability in hospitals. The results provide interesting insights for improving the operating room schedules.

4 - Fitting multiple distributions in multiple risks situations: Impact on health economic evaluations **TUE-2A**

Hassan Baalbaki (University of Sheffield)

Tuesday 2A | 09:30 - 11:00 | Carré 1A

Cost effectiveness studies are used to assess different health interventions in order to provide the most efficient health care taking into consideration budget limitations.

Clinical trials and cost effectiveness analysis are complementary, as the effectiveness data extracted from the trials and then extrapolated over the lifetime of patients, in the cost effectiveness models.

In the vast majority of health economic models, fitting a single distribution into survival functions and risk events would be sufficient. However we believe that for certain complex interventions especially for patients diagnosed with chronic long term conditions, the risk function and the survivability data cannot be reduced to a single distribution. Therefore, the aim of this paper is to study the impact of such reduction on the final outcomes of cost effectiveness studies.

A practical case of patients diagnosed with heart failure and admitted to hospital after a medical event, is illustrated in this paper. In this case, we believe that the risk of death is implied by two distributions: (i) the risk due to the hospital admission and medical event (ii) risk due to the long term medical conditions i.e. the heart failure. The first risk is believed to me more pronounced but for a shorter time frame, however the second distribution is less pronounced but more consistent on the long term.

2B - Patient Flow (1) — Room: Carré 1B

1 - Patient flow analysis — TUE-2B

Nelly Litvak (University of Twente)
Niek Baer, Nikky Kortbeek

Tuesday 2B | 09:30 - 11:00 | Carré 1B

In this talk, we present a quantitative analysis for patient flows in pain rehabilitation, based on a case study in the rehabilitation center 'Het Roessigh', The Netherlands. In order to tackle its organizational challenges, such as long waiting lists and high working pressure on the practitioners, Het Roessingh is introducing the concept of 'treatment plans'. Treatment plans specify the required treatment for specific groups of patients with the same diagnosis during a period of several weeks or months. The models developed in this study will support Het Roessingh to gain insight in the behavior of their care chain, once the treatment plans are introduced. In particular, we evaluate: the number of intakes needed per week; the capacity loss as a result of cancellation of interdisciplinary meetings, during which patients can be discharged; the capacity requirements per discipline as a result of patient flows induced by treatment plans. Next, we propose a staffing policy that ensures short waiting times and balanced load across the disciplines. The methods and analyses presented in this talk are based upon Operations Research techniques. The analysis enables us to advise Het Roessingh on the optimal system configuration of the treatment plan based care chain and to derive rules of thumb that can be applied in its design and control.

2 - A model of CCU activities through queueing theory — TUE-2B

Izabela Komenda (Cardiff University)
Jeff Griffiths, Vincent Knight

Tuesday 2B | 09:30 - 11:00 | Carré 1B

The random behaviour of arrivals and lengths of stay within a Critical Care Unit (CCU) make for a complex system. As such, dealing with the growing constraints on the healthcare system at the acute level is difficult. In this study queueing theory is used to develop a new mathematical model of patient flow. Predictions from the model are compared to the observed performance of the Units in the real world, and the sensitivity of the model to changes in Unit size is explored. We also propose a queueing network model of two CCUs to study the effect of patient diversion. We further model the network as a non cooperative game where each CCU aims to have a utilization rate below 80% and chooses its diversion threshold based on the number of beds occupied. Four different models are considered and the effect of targets, demand and capacity are studied.

3 - Discharge planning to mitigate hospital congestion and bed block **TUE-2B**

Jonathan Helm (Indiana University)
Rene Bekker, Mark van Oyen

Tuesday 2B | 09:30 - 11:00 | Carré 1B

Bed block in hospitals leads to long waits in Emergency Department, patients being placed in the hallways on stretchers, poor quality of care, high costs and mortalities. The timing of discharges from inpatient beds significantly impacts bed block. This research models the census as a function of the controllable components of the discharge process. The purpose is to understand how the hospital can better manage the discharge process to avoid the prevalent midday congestion that leads to bed block. To do so we analyze a stochastic process of hospital census and examine the efficacy of different approaches to modifying the discharge process in terms of reduced peak occupancy levels and bed block. Some key measures we consider include the timing of discharge processing by medical professionals, the speed of exiting a bed, and the availability of hospital resources required for a successful discharge (e.g. pharmacy, rehab, etc.).

4 - Systems dynamics modelling for specialist outpatient flow **TUE-2B**

Kiok Liang Teow (National Healthcare Group)
Jamie Mervyn Lim, Kannapiran Palvannan

Tuesday 2B | 09:30 - 11:00 | Carré 1B

Patient flow is complex due to multiple flows between service points, demand and supply variability, and delay. This work studies capacity planning for Specialist Outpatient Clinics (SOC). SOC see patients referred from within hospital, including accident and emergency, inpatient discharges and inter-specialty referrals. It also receives external referrals from public and private primary care, and some walk-ins. Operational issues include: (i) first visits (FV) attendances needing one or more repeat visits (RV) before discharge; (ii) patients defaulting appointments and may be rescheduled; (iii) a triaging system allowing more acute patients to be seen earlier.

We look at two hospital measurements that track and plan SOC resources. One is total RV to FV attendances ratio. This guides clinics to plan relative number of FV and RV sessions. Many equate this ratio to an average patient pathway ratio as it measures the number of follow-up that each patient will need. Another is Appointment lead time, measuring time from FV request to appointment. This is a proxy indicator of accessibility.

We use system dynamics to map and simulate SOC flow using administrative data. We show that RV-FV ratio is useful but needs to be interpreted carefully as it does not consider capacity constraints, patient acuity, appointment lead time, or even how funding mechanisms can affect medical practice. Our simulation also suggests that feedback mechanism exists and stabilises FV lead time. When FV lead time is seen in isolation, this mechanism may mask the need for sustained capacity building.

1 - Behavioral aspects of operating room planning **TUE-2C**

Andreas Fügener (Technische Universität München)
Sebastian Schiffels, Rainer Kolisch

Tuesday 2C | 09:30 - 11:00 | Carré 1D

Planning surgeries is a critical task in operating room management. On the one hand, operating rooms are bottleneck resources which need to be utilized efficiently. On the other hand, overtime for employees caused by tight schedules should be avoided. Both, planning with too long and too short time estimates for operations, lead to additional costs. These costs are defined as operating room inefficiency in the literature. Examples for operating room inefficiency are idle time when planning with too long time estimates and overtime or rescheduling of surgeries when planning with too short time estimates. The overall objective is to minimize the expected value of operating room inefficiency due to the uncertain duration of surgeries. Most literature on operating room planning assumes rational behavior. However, behavioral studies have shown that decision makers deviate from rational behavior in real life. We set up an experimental study where surgeons where asked to schedule a set of operations with uncertain durations. We find systematic deviations from optimal decision making. We give a detailed analysis of the scheduling behavior of the surgeons and provide explanations. Even in a simplified environment the scheduling behavior of surgeons is inefficient and leads to avoidable costs.

2 - Planning elective surgeries in a Portuguese hospital using a genetic heuristic **TUE-2C**

Inês Marques (Universidade Lusófona de Humanidades e Tecnologias)
Maria Eugénia Captivo, Margarida Vaz Pato

Tuesday 2C | 09:30 - 11:00 | Carré 1D

Reduced budgets in the healthcare sector pressure health institutions to an efficient use of resources. The operating theatre is a hospital unit that represents a great proportion of the hospital budget. Furthermore, it is a central service with connections and implications in the service of many other hospital units. A more efficient use of the operating room becomes of great relevance within the hospital administration. This work provides therefore a contribution using operational research to the guideline of improving the efficient use of hospital resources by proposing a methodology for the elective surgery planning problem in a public hospital in Lisbon. The objective is to maximize the usage of the surgical suite.

A genetic heuristic is proposed and applied to real data from the studied hospital. The solution representation is a Days x Rooms chromosome. Each gene represents the surgical specialty that is assigned to each room and day. The chromosome decoder uses heuristic procedures to build a solution. An elitist chromosome is included in the initial population. The algorithm uses a multi-point crossover and replacement is generational. This approach proved to be very fast, provided good quality solutions and improved the solutions obtained with previous solution approaches to this problem.

At the talk, the genetic algorithm developed will be presented and the results of its application to real data from the hospital will be discussed and compared with results obtained with previous approaches, namely an integer linear programming methodology and simple heuristics.

3 - A robust approach for scheduling in healthcare considering multiple objectives **TUE-2C**

Sebastian Rachuba (Ruhr University Bochum)
Brigitte Werners

Tuesday 2C | 09:30 - 11:00 | Carré 1D

The allocation of limited resources in hospitals is a challenging task as stochastic influences have a major impact on the final allocation. Therefore, uncertainties of treatment durations and of emergency arrivals have to be taken into account explicitly. Besides, we focus on different decision-makers objectives which we consider separately. A scenario-based multi-objective mixed-integer optimization model is presented in order to integrate the aforementioned aspects. We suggest a robust approach based on different scenarios to ensure that the resulting schedule is feasible. Information on stochastic parameters should be integrated into the planning model in order to avoid re-scheduling during the planning period. Thus, the final schedule can be communicated e.g. to surgeons and patients at an early stage which is beneficial for a smooth care-process. Additionally, we explicitly consider the interests of several stakeholders, e.g. patients, staff and management. These interests can be represented using different objective functions which aim at maximizing / minimizing their individual goals. As the individually optimal solutions for the different stakeholders are likely to differ we aim at identifying a good compromise solution. Thus, we focus on several concepts in order to balance the individual interests with respect to a robust solution. These concepts for a compromise schedule are evaluated in a case study using real-world data from a German hospital. We compare different compromise schedules with respect to several performance criteria according to various stakeholders preferences and evaluate the presented concepts.

4 - Optimization via simulation: An approach to the operating room scheduling problem **TUE-2C**

Fabrício Sperandio (Universidade do Porto)
Bernardo Almada-Lobo, José Borges

Tuesday 2C | 09:30 - 11:00 | Carré 1D

The Operating Room (OR) has a strong impact on key hospitals financial and social indicators. Nowadays, governments are cutting healthcare budget, while on the other hand, surgical waiting times are rising due to aging population and better access to surgical treatments. In this context, there is an urgent need for appropriate management tools to face such challenges. OR surgery planning & scheduling problems have combinatorial and stochastic features. The combination of both demands a high computational cost, leading researchers to build simplified models, often neglecting the effects of uncertainty. However, once addressing the uncertainty arising in healthcare management problems, computer simulation is considered to be the most suitable tool. Moreover, recent advances in computer power allow simulation models to be optimized. This work presents preliminary results of the development of an Optimization via Simulation (OvS) approach to the OR scheduling problem at the operational level. OvS approaches differ from deterministic optimization approaches since the objective function cannot be measured precisely, but only estimated, requiring a high estimation cost. Our approach tackles this issue with two distinct features: (1) statistical ranking & selection procedures and (2) metamodels based on neural networks. Both features are integrated into the search procedure aiming to improve efficiency, while reducing the number of replications required to estimate performance and ensure statistical validity. We aim to develop a decision support system able to proactively manage the impact of uncertainty on schedules performance measures, thus helping decision makers to reduce costs, as well as surgical waiting lists.

1 - Simulation based optimization of the operating theatre program TUE-2D

Daniëlle Ekkel (ZGT Almelo / Hengelo)
Martin Leferink, Jasper Quik, Michel Kats, Erwin Hans

Tuesday 2D | 09:30 - 11:00 | Carré 1C

We present a research project of the hospitals from Ziekenhuisgroep Twente in collaboration with CHOIR/University of Twente, regarding the optimization of the operating theatre planning, using an extensive operating theatre modeling and simulation software developed by CHOIR/University of Twente. We present the software used, the outcomes of the analyses made, and resulting operating theatre planning interventions.

2 - Grouping of medical disposable items into custom packs: A mathematical programming approach TUE-2D

Brecht Cardoen (Vlerick Leuven Gent Management School / KU Leuven)
Jeroen Beliën, Mario Vanhoucke

Tuesday 2D | 09:30 - 11:00 | Carré 1C

Custom packs group medical disposable items into a single sterile package that is used for surgical procedures. Although custom packs constitute a well-known concept in the hospital setting, little is known on methodologies to configure them, especially if the number of medical items, procedures and surgeons is large. We propose a mathematical programming approach to guide hospitals in developing or reconfiguring their custom packs. In particular, we optimize the configuration process so that human contact of materials, the number of configured packs and the cost of waste is optimized. We develop an intuitive integer non-linear programming model which we eventually linearize and apply to real data of a medium-sized Belgian hospital. We report on the crucial data gathering phase and the problems we encountered in retrieving accurate information. A computational experiment compares the optimized results with the performance of the current configuration settings and indicates how to improve the custom pack usage. Multiple scenarios are listed and evaluated, such as the development of surgeon-specific or discipline-wide custom packs. We point at some interesting insights that can be taken up by the hospital management to guide the configuration and accompanying negotiation processes, both internally (surgeons) and externally (vendors).

3 - Tactical planning in ZGT Almelo/Hengelo TUE-2D

Michel Kats (ZGT Almelo / Hengelo)
Jasper Quik, Manon Bruens

Tuesday 2D | 09:30 - 11:00 | Carré 1C

The hospitals from Ziekenhuisgroep Twente are aligning supply and demand by an innovative tactical planning concept. This encompasses frequent gathering of information about recent capacity utilisation, access times, and demand expectations in the short term. Based on this inventory, operating theatre capacity is reallocated, and waiting lists are reduced, and under-utilisation is avoided. This presentation addresses the pitfalls and success factors for the implementation of 'tactical planning'.

4 - Variations in the patient care process at the emergency department: Development and implications of an observational instrument **TUE-2D**

Maartje Zonderland (University of Twente / Zonderland ZorgLogistiek)
Daisy Koks, Christian Heringhaus

Tuesday 2D | 09:30 - 11:00 | Carré 1C

In this talk we discuss the development and implications of an observational instrument, designed to evaluate treatment routines at an Emergency Department (ED). The instrument divides all different types of activities a doctor can perform at an ED into eight categories. In 2010, a pilot study with the instrument was carried out at the ED of Leiden University Medical Center. All physician activities were registered on a minute-to-minute base by an independent observer. Ten doctors were observed during a total of Âś 36 hours in which 42 patients were seen. Although emergency physicians were observed for a shorter period of time than internists, they saw more patients. Emergency physicians tended to have more patient contact time than internists, but both groups dedicated most of their time to documentation and had little communication with emergency department nurses. The average LOS of internal patients was significantly higher than for the patients of emergency physicians. By protocol, patients at the Emergency Department (ED) who are seen by emergency physicians are treated one by one, resulting in a more or less serial treatment routine. Physicians from other departments tend to see more patients at the same time (parallel treatment routine), and thus occupy more treatment rooms simultaneously. We suspect that the parallel treatment routine is related to a longer patient LOS and suboptimal ED logistics. In a succeeding study we will mathematically compare the advantages and disadvantages of serial and parallel treatment routines at the ED.

1 - Are numbers still killing people: And what is being done about it? TUE-3A

Penelope Mullen

Tuesday 3A | 11:30 - 13:00 | Carré 1A

A paper presented earlier at ORAHS - Killing by numbers: Can it be ethical for quantitative analysis to result in avoidable death? - argued that pursuit of the superficially-attractive and apparently-scientific objective of health-gain maximisation had resulted in potentially life-saving or life-prolonging treatment being denied because it is deemed to cost too much per QALY (ie exceeds a pre-determined cost/QALY threshold). It then asked whether this could lead to compulsory euthanasia for those whose cost-per-QALY is deemed too high? None of the ethical arguments explored demonstrated convincingly that this could not happen. Ensuing papers questioned the appropriateness of adopting health-gain maximisation as a principal objective of health care systems as advocated by many health economists and also implicitly or explicitly by many policy makers in the UK. Those papers also explored what might be appropriate health-system objectives.

Recently some proponents of health-gain maximisation, whilst arguing that providing treatments above the cost/QALY threshold would unfairly deprive others of more efficient health care and so reduce aggregate heath gain, have recognised the potential for inequity and adverse headlines resulting from its pursuit. This has led to a number of proposals and policies to attempt to address the concerns.

This paper reviews the debates on the risk of compulsory euthanasia and appropriate health-service objectives, examines the extent to which recent UK (England and Wales) policies and proposals address the various concerns and re-considers the role and dangers of quantification in health care policy and priority setting.

2 - Can minutes really save years? Simulation modelling for understanding the effect of fast and appropriate access to stroke thrombolysis on functional outcomes and long-term stroke burden TUE-3A

Leonid Churilov (Melbourne Brain Centre)
Mahsa Keshtkaran, Andrew Flitman, Helen Dewey, Geoffrey Donnan

Tuesday 3A | 11:30 - 13:00 | Carré 1A

Stroke is the third most common cause of death and the sixth most common cause of disability worldwide. Treating acute ischemic stroke with thrombolysis within 4.5 hours from symptom onset is effective in improving patient outcomes. A need for simultaneous systemic evaluation of multi-factorial interventions in acute stroke care systems, aimed at improving patients outcomes through increasing their eligibility for stroke thrombolysis, is well recognized both in the clinical literature and by stroke services operations managers. To support such evaluation, we earlier developed a simulation model that provides clear measure of the relative benefit of alternative potential interventions in pre-hospital stroke care operations. In this study we improve this model by explicitly linking availability of stroke thrombolysis services, time from stroke onset to arrival to hospital, patients age, gender, and stroke severity, to functional outcomes at 3 months post-stroke and, subsequently, stroke burden measured as disability-adjusted life years. The new model extends across the whole acute stroke care chain and provides a valuable tool for systematic investigation into the relationship between various components of the acute stroke care system. In particular, we use this model to address an important question of whether, given a certain availability of thrombolysis services, fast and appropriate actions immediately after the stroke event results in tangible improvement in disability-adjusted years

of life in the long term. The strengths of the model include its novel across-the-whole-acute-stroke-care-chain nature, as well as firm grounding in contemporary empirical findings in the area of clinical stroke and stroke burden assessment.

3 - New insights on integer-programming models for the kidney exchange problem **TUE-3A**

Abdur Rais (University of Minho)
Miguel Constantino, Ana Viana, Xenia Klimentova, Filipe Alvelos, Joao Pedro Pedroso

Tuesday 3A | 11:30 - 13:00 | Carré 1A

In recent years, several countries have set up programs that allow exchange of kidneys between two or more incompatible patient-donor pairs. These programs are commonly known as Kidney Exchange Programs, and the underlying optimization problems are typically modeled as integer programs. However, these previously proposed models have exponential number of constraints or variables, which makes them fairly difficult to solve when the problem instances are large. In this work, we have developed compact models for the problem that have certain advantages over the previous models. We present systematic comparison between our models and the two previous ones via thorough computational analysis. We also highlight advantages and disadvantages of each model and provide results on dominance of some models over others.

4 - Combining high tech with human touch by doctors at Federal Medical Centre Makurdi **TUE-3A**

Msugh Moses Kembe (Benue State University)

Tuesday 3A | 11:30 - 13:00 | Carré 1A

This paper studies the application of diagnosis using high tech at the same time bringing human touch to bear in the process at the Federal Medical Centre Makurdi. The problem of epileptic power supply and the attendant high cost of running generating sets to power the equipment at the medical center have slowed down the use of high tech at the health facility. The technical expertise of many of the doctors at the health facility is inadequate especially that many of these technologies are new inventions alien to them and need to update. It was established that patients are more comfortable with the blending of physical examination with high tech than solely depending on high tech for medical examination and the need for human touch is a matter connected with the psychology of human nature.

3B - Patient Flow (2) — Room: Carré 1B

1 - Health planning via discrete event simulation: A breast screening case study — TUE-3B

Paolo Tubertini (Università di Bologna)
Alberto Caprara, Andrea Lodi, Francesca Senese, Roberto Grilli

Tuesday 3B | 11:30 - 13:00 | Carré 1B

Agenzia Sanitaria e Sociale Regionale of Emilia Romagna, a regional center for innovation and improvement, is trying to understand how OR and DES can be incorporated as new tools for planning decisions, complementary to others already in use. Most of decision support systems used by regional and local health planners face problems from the epidemiological point of view and few studies are focused on dynamic capacity planning. The aim of this work is to study how two different DES software packages can be effectively applied to support tactical and operative decision making processes. In order to show the potential of DES modelling we built a breast screening pathway and we show how this model can predict lead time performance with different capacity settings. We focus our work in 45-49 and 70-74 women age bands inclusion that took place in 2010 showing how simulation can help in understanding how many resources the screening program needs in order to face an increased demand of services. We analyze the screening program with two DES software packages in order to show how different tools can help stakeholders that operate at different decision levels (local vs. regional). We compare our results with the observed performance in order to validate the model with health managers and we discuss if and how simulation tools can be included as organizational tools for their future planning processes.

2 - An operational model for comparison of health services for diabetes II between six countries — TUE-3B

Sylvia Elkhuizen (Erasmus University Rotterdam)
Mahdi Mahdavi, Tom Bowen

Tuesday 3B | 11:30 - 13:00 | Carré 1B

The Managed Outcomes project explores the assumption that healthcare outcomes and costs are affected by the efficiency of service production, the time/location constrained regional structure of healthcare delivery, and the degree to which people are empowered to participate in the co-production of their care. The project uses three different complementary research strands to explore the assumption: case instance research, literature review and survey research. The survey and case instance research are performed for four different patient groups in six countries. In the case instance research, we developed a general operational model for comparing demand, health services, resources and costs.

This presentation focusses on the case instance research of the Diabetes Mellitus type II (DM II) care processes. For this patient group a stage model was developed which represents three different stages in the care for DM II patients: life style advice, oral medication and insulin injections. For each of the stages the health services are modelled, using health service elements as building blocks. Resources and costs are linked to these health service elements. The model also includes clinical outcome measures. The model is applied in different regions in the Netherlands, Finland, Spain, and Greece and partly in Germany. A different model with comparable data is applied in the United Kingdom.

3 - Assessing the impact of organizational changes in clinical pathways **TUE-3B**

Yasar Ozcan (Virginia Commonwealth University)
Elena Tànfani, Angela Testi

Tuesday 3B | 11:30 - 13:00 | Carré 1B

In this work we focus our attention on the analysis and management of Clinical Pathways (CPs), from an operational point of view, where the CP is "the path" followed by a patient with a given pathology through the health-care system. The study objective is to develop a modeling framework aimed at analyzing the pathway of patients with common acute diseases, and highlighting not only variability but also critical points, bottlenecks, identifying the best organizational model of care and the proper sizing, as well as optimal management of resources. This framework has been applied to a case study for the thyroid surgical treatment using the data collected at a Department of Surgery of a public hospital sited in Genova (Italy).

The model identifies the fundamental activities that make up the CP as an integrated project with many tasks to be executed. Next, the CP has been modeled with a discrete event simulation model in order to discover the critical activities and scarce resources that represent the process bottlenecks both from a patient-centered and facility-centered point of view. The simulation model has been designed to analyze the three main operative areas which the flow of surgical patients within the hospital is decomposed: waiting list management, operating theatre planning and bed ward organization. These operative areas also correspond to the main resources that impact on the CP duration and patient waiting time. Finally, the Optimizer, an optimization module, integrated with Witness simulation environment has been used to identify the best scenario, i.e. to find the configuration of the resources that minimizes the patient waiting time.

4 - Clinical pathways: Insights from a multidisciplinary literature survey **TUE-3B**

Bernadetta Addis (Università degli Studi di Torino)
Roberto Aringhieri, Elena Tànfani, Angela Testi

Tuesday 3B | 11:30 - 13:00 | Carré 1B

The Clinical Pathways (CPs), also known as Integrated Care Pathways (ICP), Multidisciplinary pathways of care, Pathways of Care, Care Maps, Collaborative Care Pathways, can be defined as "health-care structured multidisciplinary plans that describe spatial and temporal sequences of activities to be performed, based on the scientific and technical knowledge and the organizational, professional and technological available resources".

The medical literature is very rich and a plethora of papers have been put forward to develop CPs for specific diseases and pathologies. Many studies show that, appropriately implemented, CPs have potential to reduce patient length of stay and limit variability in care, thereby yielding cost savings.

On the contrary, the OR&MS literature focused on giving modelling insights to make CPs operative in the current health service delivery system and improve their impact on the organization, is particularly poor. It seems that no consolidated agreement exists to fine tune clinical CP requirements with the optimal management of resources.

The aim of our work is twofold. Firstly, we analyse the relevant literature on CPs and propose a classification scheme to be used for researchers on this topic that covers the medical, economical and OR&MS area. Secondly, we discuss a general quantitative model to globally approach the analysis of a clinical pathway in such a way to make the clinical point of view, implicit in the CP approach, compatible with economic and managerial requirements and to account the improvements gained by subsystem optimisation.

1 - Consistent home health care service TUE-3C

Thierry Garaix (École des Mines de Saint-Étienne)
Dominique Feillet, Fabien Lehuédé, Olivier Péton, Dominque Quadri

Tuesday 3C | 11:30 - 13:00 | Carré 1D

Last years, assignment and routing optimization of nurses visiting patients have been extensively studied in the context of Home Health Care Services. Such problems are often modeled as rich vehicle routing problems, involving side constraints as time windows. Periodicity of care has also to be considered since patients are to be visited repeatedly along a given time horizon. In this work, we guarantee a consistent service in terms of times of service and nurses. Time-consistency ensures close visiting times on each day for each patient. Such constraints couple days and give a special structure of the underlaying optimization problem. We propose an exact solution approach based on column generation and branch-and-price for this problem that we named Time-Consistent Vehicle Routing Problem (TCVRP). We also propose a set of valid inequalities dedicated to the TCVRP Results demonstrate the interest of this approach compared to using a solver on a compact formulation.

2 - A robust programming model for the assignment problem in home care services TUE-3C

Ettore Lanzarone (Consiglio Nazionale delle Ricerche)
Giuliana Carello, Andrea Matta

Tuesday 3C | 11:30 - 13:00 | Carré 1D

Home Care (HC) includes medical, paramedical and social services which are delivered to patients at their domicile rather than in hospital. Managing human and material resources is a difficult task, because the HC provider has to synchronize the use of resources, to deal with peculiar constraints (e.g., the continuity of care) and to manage the high variability of patients demands.

Under continuity of care, one of the main issues encountered in the planning is the nurse-to-patient assignment. Despite the importance of this topic, the problem is only marginally addressed in the literature, where it is solved adopting the stochastic programming or analytical policies. However, both these approaches proved to be limited, even if they improved the quality of the assignments with respect to those actually provided by HC providers in practice.

In this paper, we develop a robust assignment problem, which allows exploiting the potentialities of a programming model rather than an analytical approach, without the necessity of generating scenarios.

The developed model is finally applied to a relevant HC provider operating in Italy, in order to evaluate its capability of reducing the variable costs related to nurses overtimes, and to compare the results with both the real practice of the analyzed HC provider and the previously developed approaches.

3 - The nurse-patient assignment problem in home care **TUE-3C**

Bushra Bashir (Université Blaise Pascal)
Christophe Caux, Michelle Chabrol

Tuesday 3C | 11:30 - 13:00 | Carré 1D

Home health care, i.e. visiting and nursing patients in their homes, is a growing sector in the medical service business. In this type of treatment, the care is provided to patients while living at their homes. The care providers e.g. nurses, doctors travel to patients homes. The patients and care providers can be at different geographical positions. Therefore minimizing the travelled distance is one of the important objectives of home care sector in order to save the resources. In this paper, we have solved the problem of assigning patients to nurses in order to reduce the travelled distance (i.e. cost). The new feature that we added to this problem is to consider their geographical positions while doing assignments. The required qualification of nurses is guaranteed via compatibility constraints. A binary integer programming model is formulated to assign the nurses in different periods. This model is solved by LINGO 6.0. Computational tests are performed for different scenarios in order to analyze the tradeoffs among different performance measures.

4 - Combining routing and rostering for the home health care problem **TUE-3C**

Hanane Allaoua (Université Paris)
Sylvie Borne, Lucas Létocart, Roberto Wolfler Calvo

Tuesday 3C | 11:30 - 13:00 | Carré 1D

Home health care (HHC), i.e., visiting and nursing patients at home, is a growing sector in the medical care system, therefore the problem of how to schedule the health care staffs arises. The objective of this problem is to construct routes and rosters for the staffs by optimizing costs. The patients to be treated may require (possibly) several cares and each one is characterized by a required skill, a treatment duration and an earliest and a latest starting time. Each health care staff is characterized by a skill and by a time window within which the health care staff must leave and return to its home (office). In our problem we also assign health care staffs to a set of shifts. A shift is characterized by a time window and a skill.

Initially we propose an integer linear programming formulation (ILP) and we tested this model on small instances. To deal with larger instances we are developing a matheuristic in which we decompose the ILP formulation into two problems. The first one solves the rostering part of our problem which represents the set partitioning problem. We will solve it with a heuristic approach. The second problem solves the routing part which is equivalent to a shortest path problem with time windows (SPPTW), we will solve the SPPTW using an exact method and the result will be used as data for the set partitioning problem. Some computational results obtained on instances coming from the literature will be presented.

3D - Interaction between OR and Ward: From Theory to Practice **Room: Carré 1C**
This session is sponsored by Information Builders.

1 - Implementing algorithms to reduce ward occupancy fluctuation through advanced planning **TUE-3D**

Peter Vanberkel (Dalhousie University)
Richard Boucherie, Erwin Hans, Johann Hurink, Wineke van Lent, Wim van Harten

Tuesday 3D | 11:30 - 13:00 | Carré 1C

Well-designed surgical schedules which take into account inpatient ward resources lead to reduced cancellations and higher and balanced utilization. A model was developed in conjunction with NKI-AVL to redesign their master surgical schedule which, through better use of ward capacity, allowed an additional operating room to be built without ward expansion. The success of this project served as proof-of-concept for our model which has been applied in several Dutch hospitals. To further disseminate our model, we partnered with Information Builders and developed a commercial version of it. Our model is currently being offered to Dutch hospitals and marketed worldwide.

2 - Linking the OR block plan with bed utilization: From model to implementation **TUE-3D**

Edgar de Groot (Information Builders / iWay Software)

Tuesday 3D | 11:30 - 13:00 | Carré 1C

In this talk, Information Builders will show how its Information Management product, WebFOCUS, can be used to fit in advanced models and algorithms within a ready-to-use system for the operational user. One example of a successful implementation using the software of Information Builders is a model to optimize the relation between the OR block plan and the bed utilization. This work is done in collaboration with the NKI-AVL (Netherlands Cancer Institute - Antoni van Leeuwenhoek Ziekenhuis) and the Centre for Healthcare Operations Improvement & Research (CHOIR) of the University of Twente.

3 - A model to reduce ward occupancy fluctuation through advanced planning: From theory to practice **TUE-3D**

Renske Visser (The Netherlands Cancer Institute - Antoni van Leeuwenhoek Hospital)

Tuesday 3D | 11:30 - 13:00 | Carré 1C

In this presentation the NKI-AVL will show how WebFOCUS, the Information Management product of Information Builders, was implemented to improve the bed utilization by alternating the master surgery schedule. To make implementation possible several iterations have been performed in which the model outcomes were validated by comparing them to hospital data and the model was adapted to increase the reliability of the results. Subsequently WEBFOCUS was used to find a surgery schedule that balances the bed utilization on the wards.

4 - Using operation research in real life hospital capacity management **TUE-3D**

Bernd van den Akker (Isala klinieken)

Tuesday 3D | 11:30 - 13:00 | Carré 1C

Is there an analogy between weather forecasting and a hospital? How do we translate strategic decisions into daily operation? In this presentation we will discuss the use of academic operation

research results into daily practice. How we support planners, doctors and nurses to create an effective and efficient hospital. The Isala klinieken in Zwolle, is one of the largest non academic hospitals in the Netherlands. We work closely together with the University of Twente and accommodate students in their master project.

Keynote Talk 3 **Room: Waaier 2**

Translating operations research methods into hospital practice; Evidence base and factors influencing optimal use — TUE-K3

Wim van Harten (The Netherlands Cancer Institute - Antoni van Leeuwenhoek Hospital / University of Twente)

Tuesday K3 | 14:00 - 14:30 | Waaier 2

In recent years, health care institutions and especially hospitals are challenged by governments and insurance agencies to improve efficiency especially out of concern for the financial sustainability of health care spending. In combination with a growing emphasis on patient centeredness, there is a need for logistic improvement. We increasingly see a tendency to emphasize process improvement, whereas this was so far 'just' an element of quality management, and especially techniques from Operations Research (OR) are explored and used in this field.

However, there seems to be a chasm between the OR field and hospital practice. Groups active on the OR side seldom have direct links to hospitals to experiment with their algorithms or simulations and creating an evidence base, as is often done for costly new technologies, is only at its start. Hospitals have limited access to the relevant knowledge, which is mostly presented to them in relatively easy accessible ways by commercial firms, and knowledge is lacking among hospital leadership on operations management and -research.

In this presentation we will present results from a survey among 17 hospitals in the Netherlands, present our experiences from a number of relevant OR projects in the NKI-AVL in Amsterdam and identify a number of critical factors for both the OR field and hospital leadership to improve the implementation success of OR interventions.

Lastly we will explore the evidence base and suggest actions to improve the evidence in order to more easily convince hospital leadership and clinicians to adopt these techniques.

Discussion Session **Room: Waaier 2**

Applying OR models in healthcare practice: Is there need for more advanced models? — TUE-DS

A panel consisting of both academics and practitioners

Tuesday DS | 14:30 - 15:30 | Waaier 2

During this plenary discussion session academics and practitioners can discuss the applicability of OR models in healthcare practice. Participants from both ORAHS 2012 as from the symposium 'Operations Research Applied to Health Service: from theory to implementation' take part in the discussion. A panel group will open the discussion, but the audience is welcome to share their opinion.

1 - Prevention programs for occupational injuries: Cost analysis and targeted resource allocation TUE-4A

Marion Rauner (University of Vienna)
Michaela Schaffhauser-Linzatti, Johannes Bauerstätter

Tuesday 4A | 16:00 - 17:30 | Carré 1A

Occupational injuries are a great burden on health care costs worldwide. We develop a detailed decision for support system called cost calculation tool for the main Austrian occupational insurance company (AUVA) that investigates the total direct and main indirect costs of individual injury claims from the time of the incident of all injured individuals up to their death. For example, in the first two years, treatment costs account for about 66%, pension costs for about 12%, and co-payments for sick leave for about 10% of the total AUVA costs. For example, a costly case of the 2010 data is a middle-aged male who had a car accident at work in 2008 and injured his back with costs over 313,000 Euro (pension, treatment, rehabilitation, prosthesis, transportation) for the years 2010 and 2011. However, pension costs are the main cost driver with nearly 50% of total AUVA costs for a lifelong cost-perspective, while treatment costs then only account for less than 15%. We also approximate main costs for the employers and the economy. These calculated costs for the data of the year 2010 are included in the data warehouse of the AUVA and help clustering patients into risk groups according to criteria that most influenced related total costs. AUVA decision makers can now optimally target prevention strategies and better plan for prevention budgets. Based on these insights and former research projects, the AUVA highly focus their prevention strategies on injuries at construction sites, in the forest, and on the road to/from/at workplace.

2 - Demonstrating the benefit of OR in maximising the use of existing health related data for the Welsh Government TUE-4A

Tracey England (Cardiff University)
Sarah Lowe, Paul Harper

Tuesday 4A | 16:00 - 17:30 | Carré 1A

In October 2011, the Welsh Government recruited four Knowledge Transfer Partnerships Research Fellows to investigate how existing administrative and survey data could be used more effectively. The role of the Operational Research fellow was to identify areas within the Welsh Government where OR techniques such as computer modelling and simulation could be used to make use of existing data, highlight data that would be useful in providing policy with evidence, or develop models in a relatively data-free context to aid decision making. Progress with two specific case studies will be discussed:

Case Study 1: Using OR to assess the benefits of using Teledermatology across Wales

Teledermatology is the use of technology (e.g. videoconferencing, store and forward image transfer) in the diagnosis and triage of dermatology patients. The project considers the benefit of using Teledermatology from both the patients and clinicians perspective. A simulation model is developed to represent the clinicians working schedule. A cost-benefit analysis is undertaken to assess the benefit of reduced patient travel distances and costs.

Case Study 2: Using OR to assess the benefits of introducing a Direct Access to a Midwife approach to maternity care throughout Wales

Direct Access to a Midwife is an approach where a pregnant woman goes direct to her midwife (on realising shes pregnant) rather than going to the GP or other health professional.

The project considers the initial pathway of the woman and the effect that Direct Access to a Midwife has on her subsequent pregnancy path and associated outcomes.

3 - Crossing the OR-policy gap: System dynamics of cross-sector patient flows **TUE-4A**

Michael Carter (University of Toronto)
Ali Esensoy

Tuesday 4A | 16:00 - 17:30 | Carré 1A

This research is motivated by the desire to incorporate system-modelling tools in the policy-making process at the Ontario Ministry of Health and Long-Term Care (MOHLTC) to facilitate a better understanding of the system-wide effects of decisions, and the sources for policy resistance. The specific objective for the Cross-Sector Patient Flow Model (the model) is to develop a system dynamics simulation of the patient flows between the health system sectors in a Local Health Integration Network (LHIN), with a focus on seniors as the main cohort. In the model, similar providers are aggregated into clusters such as acute care and rehabilitation. The linkages are conceptualized to be between these clusters and not the individual providers of the LHIN. As such, this simulation can be characterized as macro-level patient flow model of a LHIN.

4 - Cognitive maps in healthcare: An analysis of reported applications **TUE-4A**

Teresa Cipriano Rodrigues (Technical University of Lisbon)

Tuesday 4A | 16:00 - 17:30 | Carré 1A

Across the literature, several authors emphasize the role of Problem Structuring Methods (PSM) in healthcare, as they allow to: clarify the nature of the complexities surrounding health systems, identify key agents of change within health systems, support these agents in giving meaningful contributions and thereby plan and implement effective interventions. One of the most well-known PSM is Cognitive Maps (CM), consisting of a network whereby each node represents a concept and each link between two nodes represents causality/influence/implication. CM allow to model, in a transparent way, significant factors, knowledge and conditions that influence decision-makers. Therefore, in recent years, there has been a growing interest in their use and related methods have emerged in order to enhance the capabilities of CM. This is the case of Fuzzy Cognitive Maps (FCM), Reasoning Maps and Bayesian Causal Maps. Hence, in order to understand how CM and related methods may help healthcare decision-makers in structuring complex problems we carried out a literature review about their applications in healthcare. The results of our research showed that the application of these methods in healthcare decision-making problems is still quite limited, as only FCM have been widely applied in this context, mainly for diagnosis and/or prediction of diseases. Therefore, although literature states that CM and related methods may help healthcare decision-makers in structuring complex problems involving multiple stakeholders, data scarcity and multiple sources of uncertainty, it is still crucial to apply these methods in healthcare real-world setting in order to validate their potential benefits to healthcare decision-making.

1 - Discrete conditional phase-type models for representing patient activity in accident and emergency TUE-4B

Adele Marshall (Queen's University Belfast)

Tuesday 4B | 16:00 - 17:30 | Carré 1B

This paper introduces a special type of Discrete Conditional phase-type model (DC-Ph) for representing patient length of stay in hospital. The DC-Ph model consists of two components (Marshall et al., 2007). The first component is a representation of the inter-relationships between the predictor variables which are conditioned on the second component that models survival time. The Coxian phase-type distribution is used to represent the second component, the survival time to absorption of a finite Markov chain in continuous time, when there is a single absorbing state and the stochastic process starts in the first transient state (Neuts, 1981, Latouche, 1999). The DC-Ph model has previously been used to represent patient length of stay within hospital by using a Bayesian network to categorise patients into cohorts with similar length of stay using patient characteristics and then based upon this classification, employ the Coxian phase-type distribution to represent patient length of stay.

This paper wishes to extend the current form of the discrete conditional phase-type models to include more recent developments in the use of alternative approaches of classification for the first component. The work is illustrated using data reported for patients arriving to the Accident and Emergency unit of a local hospital. Based on patient information available on arrival to hospital, the model can predict the patients likely to experience trolley waits and plan ahead to prevent such cases happening.

2 - Use of queue modelling in the analysis of elective patient treatment governed by a maximum waiting time policy TUE-4B

Dawid Kozlowski (University of Southern Denmark)
Dave Worthington

Tuesday 4B | 16:00 - 17:30 | Carré 1B

Many public healthcare systems struggle with excessive waiting lists for elective patient treatment. Different countries address this problem in different ways, and one interesting method entails a maximum waiting time guarantee. Introduced in Denmark in 2002, it entitles patients to treatment at a private hospital in Denmark or at a hospital abroad if the public healthcare system is unable to provide treatment within the stated maximum waiting time guarantee. Although clearly very attractive in some respects, many stakeholders have been highly concerned about the negative consequences of the policy on the utilization of public hospital resources. This paper illustrates the use of a queue modelling approach in the analysis of elective patient treatment governed by the maximum waiting time policy. Drawing upon the combined strengths of analytic and simulation approaches we develop both continuous-time Markov chain and discrete event simulation models, to provide an insightful analysis of the public hospital performance under the policy rules. The aim of this paper is to support the enhancement of the quality of elective patient care, to be brought about by better understanding of the policy implications by hospital planners and strategic decision makers.

3 - Optimal treatment policies for risk-averse patients with limited resources **TUE-4B**

Greggory Schell (University of Michigan)
Mariel Lavieri

Tuesday 4B | 16:00 - 17:30 | Carré 1B

We develop a modeling framework to determine when to initiate and switch medications to treat systolic blood pressurea risk factor for coronary heart disease. Within this framework, we use a Markov decision process to minimize the patients expected number of coronary heart disease events over the planning horizon while accounting for the patients risk aversion and limited resources. To capture the patients risk aversion, we use conditional value at risk measures of treatment outcomes. Resource scarcity is modeled through a resource amount that is available for expenditure on treatments over the planning horizon. Initial results from the model illustrate the diminishing returns of increased planning horizon resources. Furthermore, we identify features of the optimal policies and objective function value for varying patient types and risk aversion levels.

4 - Bed allocation using a generic Markov model **TUE-4B**

Shirin Geranmayeh (Nanyang Technological University)
Chuan Heng Foh

Tuesday 4B | 16:00 - 17:30 | Carré 1B

Decision making in health settings, mainly, deals with behavioral characteristics of doctors, nurses and stakeholders as service providers and patients and their families as service receivers. When a patient decides to approach a health setting and when he must be discharged are real time decisions made by people. On the other hand, long term decisions such as number of required beds in a hospital are tried to cover demands over time with minimum costs. Bed demand is direct consequence of arrival and discharge volume that can be volatile over time and place by place. In this research, we have developed a Discrete-Time Markov Model for two parallel queues representing different bed classes in a hospital ward independent from patients' arrival and discharge pattern. The developed model is used to minimize misplacement cost of patients over time by finding the best combination of number of beds in each class when the total number of beds is constant. Presented model which is based on conditional probabilities allows arbitrary distribution for patients' arrival, discharge and length of stay and is compatible with more complex optimization methods. The model is applied to Orthopaedic Department of a hospital in Singapore consisting of total four bed classes for private and subsidized patients. Each patient type could be served by only two specified bed classes without any inter-transmission of patients between them. The objective is to find the best proportional number of beds per class when the total number of beds in ward is constant. The empirical data available from hospital for arrivals, and patients' length of stay on daily basis is applied for case study.

1 - Patient admission scheduling with operating room constraints TUE-4C

Sara Ceschia (University of Udine)
Andrea Schaerf

Tuesday 4C | 16:00 - 17:30 | Carré 1D

We propose an extension of the PAS problem described in our previous work (Ceschia and Schaerf, 2012), which considers also constraints about the utilization of operating rooms for patients that have to undergo a surgery. We design a solution approach based on local search, which explores the search space using complex neighbourhood operators.

2 - Case mix and capacity planning: An application in a Belgian hospital TUE-4C

Guoxuan Ma (KU Leuven)
Erik Demeulemeester

Tuesday 4C | 16:00 - 17:30 | Carré 1D

Hospital case mix and capacity planning concerns both the long-term decision on patient volume and mix that can be treated annually and the medium-term decision on resource capacity and allocation within a whole hospital. Since the patient treatment involves the demand for different types of resources, such as beds and operation rooms, the hospital planning not only aims at improving the match between the stochastic patient demand and the limited resource capacity, but also at coordinating the utilization of multifold resources as best as possible. In addition, the seasonality of patient arrivals will affect the patient flow, e.g., the length of patient waiting lists, and the variable resource requirements of each patient also impact the resource utilization, which both increase the difficulty of the planning process. In this paper, we will discuss an application of the planning problem in a Belgian hospital, in which the seasonality of patient arrivals and the variability of resource requirements of patient cases are considered. The solution approach relies on mixed integer linear programming techniques together with a branch-and-price algorithm, and on a discrete-event simulation analysis. The case study clearly explains the efficiency and the effectiveness of the proposed planning methodology to advance the trade-offs between the resource utilization and the patient flow.

3 - Predicting hospital resource utilization: A fuzzy regression approach TUE-4C

Manisha Rathi (University of Westminster)
Theirry Chaussalet

Tuesday 4C | 16:00 - 17:30 | Carré 1D

Hospital staff and managers are under pressure and concerned for effective use and management of scarce resources (Patel et al., 2006). The hospital admissions management requires many decisions that have complex and uncertain consequences for hospital resource utilization and patient flow. Thus, poor decisions of prediction lead in poor hospital management which is not acceptable (Berman et al., 2001). It is interesting for health care systems to estimate the utilization of hospital resources by estimating future admissions and their length of stay in hospital. However, it is challenging to predict utilization of hospital resources due to uncertainties in future admissions and length of stay of a patient. The unplanned admission of a patient can be at high risk or low risk (Demir et al., 2008). Similarly, length of stay (LOS) of a patient can be as long, medium or short length of stay. These categories (high, medium or low) are vague or fuzzy. However, current methods and tools used to predict patients at risk of

admission fail to deal with uncertainty. The main objective of this paper is to predict patients at high risk of admission and their length of stay in the hospital for efficient hospital resource utilization. An introduction of machine learning techniques along with statistical methods like Regression methods can be a proposed solution approach to the above problem. An approach that adapts fuzzy regression methods to handle uncertain variables or uncertain relationships among the input variables (predictors) and response variable can be an efficient solution to predict patients at high risk of unplanned admission and their LOS in the hospital.

4 - Analyzing the use of hospital resources: Applying mathematical programming **TUE-4C**

Luiz Guilherme Nadal Nunes (Sarah Network of Rehabilitation Hospitals)
Sandro Barbosa de Oliveira

Tuesday 4C | 16:00 - 17:30 | Carré 1D

Objectives: Present a simple mathematical programming model for analyzing the use of hospital resources. The model was specifically developed for an elective hospital, with no emergency services, on which patients are called from waiting lists of different specialties and serviced with medical appointments, exams, hospitalizations and surgeries, if necessary.

Methods: This study consists of survey data on patient care and analysis of hospital capacity. We analyzed 7238 medical records in order to compute all subsequent services performed between 2009 and 2011. We considered hospital capacity with respect to bed occupancy, surgery, magnetic resonance imaging exam and urodynamic tests. We formulated a mathematical programming model and explored the analysis provided by the model.

Results: Through the analysis of the model results, it was possible to identify bottlenecks in the care process and establish a control for new patients admissions from different specialties, considering the objective of maximizing the number of patients served, while at the same time promoting the efficient use of hospital resources.

Conclusion: The application of mathematical programming to analyze patients admissions, while at the same time considering the use of hospital resources, is not a new issue. However, as it was proposed in this study, it is a very simple model, easy to implement, and if well suited, can provide an important management tool for decision makers.

4D - Implementing Scheduling Budgets: From Theory to Practice **Room: Carré 1C**
This session is sponsored by ORTEC.

1 - Optimal staffing under annualized hours **TUE-4D**

Egbert van der Veen (ORTEC / University of Twente)

Tuesday 4D | 16:00 - 17:30 | Carré 1C

For organizations it is often challenging to determine the budgets for workforce staffing each month, in order to match dynamics in workforce availability with dynamics in workforce demand. A legal measure allowing employers to let employees work more in busy periods and less in others is the so-called annualized hours regime. We discuss a case study of the University Medical Center Nijmegen, and apply an MILP to solve the annualized hours problem. In addition, we discuss various business questions that can be addressed with our model.

2 - Controlling workforce scheduling budgets using decision support **TUE-4D**

Martin Woudstra (ORTEC)

Tuesday 4D | 16:00 - 17:30 | Carré 1C

Once workforce scheduling budgets have been set, they have to be monitored. In each scheduling period the assigned shifts are matched to the (financial) workforce capacity. Decision support can help doing this efficiently. The decision support system discussed in this presentation is developed in close cooperation with nine care and cure customers and is part of ORTEC's workforce scheduling software ORTEC Harmony.

3 - Implementing workforce scheduling budgets: A case study **TUE-4D**

Paul Trossêl (Amerpoort)

Tuesday 4D | 16:00 - 17:30 | Carré 1C

We present a case study of Amerpoort, an organization for Mental Health Care in The Netherlands. We address how workforce scheduling budgets are determined based on available capacity and demand. In addition, we discuss practical implementation issues, and outline how decision support is used to determine and control scheduling budgets. Finally, we discuss how we managed to improve workforce scheduling efficiency at Amerpoort.

Thursday July 19th

09:00 Session 5

5A Location Problems *Room: Carré 1A*	5B Stochastic Modeling (2) *Room: Carré 1B*	5C Personnel Planning and Scheduling *Room: Carré 1C*
Honora Smith (p63) A fast spatial query algorithm for nationwide location of laboratories for HIV/AIDS blood testing in South Africa	**Jivan Deglise-Favre-Hawkinson (p65)** Stochastic modeling and optimization for integration of clinical research into clinical care	**Elizabeth Rowse (p67)** Workforce planning for a district nursing service
John Blake (p63) OR case study: Evaluating a blood distribution network in Atlantic Canada	**Paulien Koeleman (p65)** Using Markov decision theory to optimise waiting time targets	**Roberto Aringhieri (p67)** Models for multi-skilled rostering in health care
Ana Maria Mestre (p64) Hospital network planning under uncertainty	**Martin Utley (p66)** Evaluating a stochastic model of short-term bed demand	**Mieke Defraeye (p68)** A shift scheduling approach to control excessive waiting times under time-varying demand
Kenneth Korve (p64) Accreditation of health care facilities under the national health insurance scheme in Nigeria: The role of the geographical information system (GIS) tool	**Xiaolan Xie (p66)** Promise surgery start times and implementation strategies	**Bernardo Almada-Lobo (p68)** Medical doctor staffing and scheduling

10:30 Coffee/Tea *Room: Foyer Waaier*

11:00 Keynote Talk 4 *Room: Waaier 2*

Vinod Subramaniam (p69) MIRA - Top technology for patients

12:00 Lunch *Room: Foyer Waaier*

13:00 Session 6

6A Forecasting *Room: Carré 1B*	6B Appointment Scheduling *Room: Carré 1C*	Lab Tour *Start from Registration Desk*
Paul Harper (p70) MetSim: A simulation support tool using meteorological information to improve the planning and management of hospital services	**Marjan van der Velde (p72)** Organizing multidisciplinary care for children with neuromuscular diseases	

	Philip Worrall (p70) Development of a hybrid grey-fuzzy methodology to forecast future demand for long-term care	**Joost Veldwijk (p72)** Designing appointment schedules in health care: Dealing with walk-in patients	
	Valérie Dorval (p71) Forecasting post-surgical length of stay using phase-type distribution and regression tree theory	**Evrim Didem Gunes (p73)** Appointment scheduling in presence of seasonal demand	
	Dhia Jomaa (p71) Improvement of the inventory management module implemented in a pharmaceutical warehouse management system	**William Millhiser (p73)** Assessing appointment systems' operational performance with policy targets	
14:30	Coffee/Tea		*Room: Foyer Waaier*
15:00	Session 7		
	7A Emergency Care Services (1) *Room: Carré 1B*	**7B Operating Room Planning and Scheduling (3)** *Room: Carré 1C*	**Lab Tour** *Start from Registration Desk*
	Martijn Mes (p74) A simulation study of an integrated emergency post	**Stefan Creemers (p76)** The optimal allocation of server time slots over different classes of patients	
	Melanie Reuter (p74) Planning the patient transport as part of the German EMS system	**Marco Pranzo (p76)** An efficient decomposition approach for surgical planning	
	Thierry Chaussalet (p75) Using data mining and simulation for health system understanding and capacity planning: an application to urgent care	**Malek Masmoudi (p77)** Robust master surgical scheduling	
	Serhat Tüzün (p75) A multi-criteria decision model for the evaluation of emergency department performance	**Marzieh Soltanolkottabi (p77)** Capacity planning in operating rooms by means of centralized data envelopment analysis: Case study of Alzahra hospital in Isfahan-Iran	
18:00	Conference Dinner		

1 - A fast spatial query algorithm for nationwide location of laboratories for HIV/AIDS blood testing in South Africa — THU-5A

Honora Smith (University of Southampton)
Jon Smith

Thursday 5A | 09:00 - 10:30 | Carré 1A

A fast spatial query algorithm has been created to inform decision making in a nationwide rationalisation of laboratories for the testing of HIV/AIDS in South Africa. The National Health Laboratory Service (NHLS) of South Africa is undertaking a major programme to improve the availability of its services. In some rural areas, transportation of blood samples from medical facilities to the nearest laboratory can be lengthy and over difficult terrain, affecting the quality of the sample. Contrastingly, in some eastern regions there is an over-abundance of laboratory provision.

The recent growth in relational databases which have spatial query capabilities has facilitated the development of a fast algorithm to find optimal laboratory locations. The relational-algebraic capacitated location (RACL) algorithm has been developed in Microsoft SQL Server Express 2008 r2, in a C# setting. Clustering is first applied to the set of over 3,200 demand points. A basic set covering approach is then employed, using spatial commands available in the SQL server database, with modification for the maximum daily throughput capacities of laboratory testing equipment. Initially the algorithm employed Euclidean distances, calculated through SQL Server. In subsequent testing, courier drive times to nearest laboratories were obtained from GoogleÂő Maps. Geographic visualisation of solutions is achieved by means of GoogleÂő Fusion Tables.

Results obtained from the modelling of several different scenarios regarding courier times and laboratory locations have been used by decision makers in the relocation of services, initially for CD4 testing, the primary test carried out for suspected HIV/AIDS.

2 - OR case study: Evaluating a blood distribution network in Atlantic Canada — THU-5A

John Blake (Dalhousie University)

Thursday 5A | 09:00 - 10:30 | Carré 1A

In 2009 Canadian Blood Services announced plans to consolidate production facilities in the Maritime Provinces of Atlantic Canada. One of the key elements of the plan involved moving existing production facilities in Saint John, New Brunswick and Halifax, Nova Scotia, into a single facility in Dartmouth, Nova Scotia. The plan drew criticism from some stakeholder groups, including the physician association in New Brunswick and the provincial government. A detailed analysis was undertaken to address stakeholder concerns. The analysis involved both a physical comparison of the current and proposed logistics network as well as the development of a set of simulation models to evaluate the impact of proposed changes on customer service levels.

In this talk, we provide the motivation for the study, an overview of the methods used, and a summary of results.

3 - Hospital network planning under uncertainty **THU-5A**

Ana Maria Mestre (Technical University of Lisbon)
Mónica Duarte Oliveira, Ana Barbosa-Póvoa

Thursday 5A | 09:00 - 10:30 | Carré 1A

Strategic planning of a hospital network requires long term decisions like facility location and capacity relocation that must be robust to face future changes in demand and supply patterns. Strategic planning has been widely supported by location-allocation models where decisions like the opening or closing of facilities are specially driven by demand, which entails uncertainty and brings new challenges to hospital service planning. This study proposes a stochastic hierarchical and multiservice mathematical programming model for hospital planning that informs how to improve hospital systems that operate within a National Health Service structure. The developed model informs how to (re)organize the hospital system when the decision maker aims to improve access in the system while minimizing costs and when there is uncertainty in the future demand for care and in the pattern of hospital provision. The model captures other relevant features of the hospital network as: a two tier hierarchical structure with hospitals being multiservice providers; and a planning horizon is used to schedule changes in the network. In the stochastic model, uncertainty is captured by a set of scenarios that illustrate future realization of demand estimates. Thus, the model explicitly includes the designed scenarios and identifies solutions that are expected to perform better overall the possible data realization. A case study based the Portuguese National Health Service is solved illustrating how the proposed model can assist health care planners.

4 - Accreditation of health care facilities under the national health insurance scheme in Nigeria: The role of the geographical information system (GIS) tool **THU-5A**

Kenneth Korve (National Health Insurance Scheme Nigeria)
Abdulrahman Sambo, Shuaibu Indabawa, Ishaq Ndaman

Thursday 5A | 09:00 - 10:30 | Carré 1A

One of the basic objectives of healthcare planning in any part of the world is to have an equal access to health care for all, irrespective of ability to pay. This means that every residence should have equal chance to go to clinics and hospitals. To meet this objective, health authorities are required to make careful analysis about the real demand and supply of health care facilities, particularly in the area of health care facilities accessibility and utilization. Health Care Facilities Planning is one of the planning fields that uses spatial data in its resources allocation process, which can provide information on geographic accessibility of health care facilities. Today Geographical Information Systems (GIS) provide useful techniques regarding capturing, maintaining and analysing the spatial data. The purpose of this paper is to give an account of how GIS was used to support the accreditation of health care facilities under the National Health Insurance Scheme (NHIS) in Nigeria.

1 - Stochastic modeling and optimization for integration of clinical research into clinical care THU-5B

Jivan Deglise-Favre-Hawkinson (University of Michigan)
Mark Van Oyen, Blake Roessler

Thursday 5B | 09:00 - 10:30 | Carré 1B

The research focuses on the capacity planning and portfolio selection of clinical research trials in dedicated Phase 1 Performance Sites. The complex resource and time coordination needs of clinical research trials/treatments (time sensitive and resource specific treatment sequence for every patient) cannot be well managed under current methods which rely on common sense and result in long waits to start treatment, high staff overtime and resource under-utilization. Planning, forecasting and optimization methods are necessary to deal with those issues and extract the highest scientific knowledge about the disease while having a practice performing at the desired (1) service levels for their patients, (2) work conditions for their nurses and/or, (3) costs of conducting the protocols (e.g. overtime). We propose a Capacity Planning Tool and Informatics System (CAPTAIN) that takes as inputs the enrollment process and the Resource Capacities of a dedicated oncology research performance sites while optimizing the proposed clinical research portfolio to perform and the Booking strategy for the chosen portfolio. Forecasting of (1) utilization/workloads, (2) over-utilization/overtime, and (3) Time To First Treatment (TTFT) are performed to achieve desired targets for the performance metrics.

The general features of CAPTAIN enable us to broaden our scope to provide longitudinal health care coordination and clinical research integration into clinical care in the context of a complex chronic disease, Systemic lupus erythematosus (SLE).

2 - Using Markov decision theory to optimise waiting time targets THU-5B

Paulien Koeleman (VU University Amsterdam)
Sandjai Bhulai, Rene Bekker

Thursday 5B | 09:00 - 10:30 | Carré 1B

We study a setting where several servers, or doctors, serve several patient types, which have different waiting time targets and different service times. When a server becomes available, there is a choice of which patient type to treat next based on the current state of the system. This setting is found for example in emergency departments. We want to minimise the weighted sum of the fraction of patients that wait longer than their set target by choosing a good admission strategy. The most logical framework for studying dynamic decision problems like this is that of Markov decision theory. However, incorporating the probability of waiting longer than some threshold is hard to incorporate into this framework.

To address this problem, we take the state space to be either the number of free servers or the waiting time of the first patient waiting in line. This provides enough information about all other patients present. This waiting time of the first patient we approximate using a parameter that increases with an exponential rate. To get a good approximation, the state space will grow very large, making it impossible to use standard techniques for deriving the optimal policy. For the case with one type of patient we derive a closed-form expression for the value function and for the long-term expected costs. Then we use this expression to approximate the value function for a system with more patient types and perform one-step policy improvement. This gives near-optimal results, which we show in numerical experiments.

3 - Evaluating a stochastic model of short-term bed demand **THU-5B**

Martin Utley (University College London)
Christina Pagel

Thursday 5B | 09:00 - 10:30 | Carré 1B

As part of a modellers in residence programme at a paediatric hospital, we have adapted and calibrated a stochastic model of short-term bed demand for use in the context of a cardiac intensive care unit which admits planned and emergency surgical patients as well as non-surgical patients. The model is used to calculate the distribution of demand for beds for each shift over a period of up to a week, accounting for what is known of those patients already on the unit, forthcoming planned surgical admissions, non-arrival rates and historical patterns of emergency admissions. The model is intended to assist in the operational management of the unit and in setting realistic goals for the number surgical cases to schedule.

Classification and regression tree (CART) analysis was used to identify groups of patients with different length of stay characteristics, with separate analyses conducted for planned patients and those already on the unit. These CART analyses were validated using a set of data not used in the initial analysis.

Other aspects of evaluation of this form of model are less straightforward. For instance, each predicted distribution generated using the model is potentially unique. This raises a question of how the accuracy of the model should be assessed against a series of observations. In this talk, I will outline the model and then discuss the technical and non-technical issues concerning the evaluation of the work, including client and user perspectives on what would make a useful model.

4 - Promise surgery start times and implementation strategies **THU-5B**

Xiaolan Xie (École Nationale Supérieure des Mines de Saint-Étienne)
Zheng Zhang, Na Geng

Thursday 5B | 09:00 - 10:30 | Carré 1B

This paper addresses the problem of scheduling a set of surgeries planned for a given day with random surgery durations. We propose an original concept of promised surgery start times determined at the beginning of the day in order to release the surgeons from endless waiting. Stochastic programming models are proposed for optimization of promised surgery start times. In order to further reduce the waste time of operating rooms and surgeons, two-stage stochastic programming models are then proposed to design strategies for rescheduling remaining surgeries and for advancing surgeon arrivals during the course of the day. Simulation results show that the real-time surgery rescheduling is able to reduce the overall costs and surgeon advance arrivals further improves the system.

1 - Workforce planning for a district nursing service THU-5C

Elizabeth Rowse (Cardiff University)
Paul Harper, Janet Williams, Mark Smithies

Thursday 5C | 09:00 - 10:30 | Carré 1C

The UK government has recently indicated that future provision of services within the National Health Service will involve the transition of care from hospitals into the community. District nurses play an important role in caring for housebound patients whilst alleviating some pressure on other primary care services. An increase in the number and complexity of patients needs treated within the community, coupled with the predicted decline in the number of district nurses poses a potential supply and demand problem. Working closely with a district nursing service in Wales, the optimal size and skill mix of district nursing teams to meet patient demand is investigated. A two-stage model is developed that uses Monte Carlo simulation to generate patient demand, and Linear Programming to find an optimal team composition that meets this patient demand at minimum cost. This approach, novel to workforce planning in the district nursing service, gives results that indicate significant cost savings if district nursing teams are restructured for optimal skill mix.

2 - Models for multi-skilled rostering in health care THU-5C

Roberto Aringhieri (Università degli Studi di Torino)
Bernardetta Addis, Maria Paola Scaparra, Andrea Grosso

Thursday 5C | 09:00 - 10:30 | Carré 1C

Workforce optimisation deals with the problem of assigning human resources to work taking into account resource-specific skills and efficiencies is a general planning task which has to be performed in any organization. It is of particular importance for service organisations (such as in health care) where the labour intensity is higher and multi-skilled resources are more common. Furthermore, especially in the health care sector, workforce structure is also characterised by skill limitation due to turnover and learning/training requirements. This makes the skill limitation a persistent and relevant issue when dealing with workforce optimisation.

The workforce optimisation based on forecasted demand gains more relevance when the medical workforce have to guarantee the efficiency and fairness of the delivered service. To the best of our knowledge, the idea of using forecasted demand for driving the optimization process has received little attention in the literature.

In this paper we deal with the problem of determining a roster taking into account multi-skilled personnel and their efficiency in such a way to satisfy a set of skill requirements and a forecasted demand of service, respectively. To provide a fair service, the proposed models aim at maximizing the minimum amount of additional demand that can be served. This objective matches a robustness requirement. We propose and compare different modelling approaches to the above problem. The proposed models are then tested on a case study benchmark.

3 - A shift scheduling approach to control excessive waiting times under time-varying demand **THU-5C**

Mieke Defraeye (KU Leuven)
Inneke van Nieuwenhuyse

Thursday 5C | 09:00 - 10:30 | Carré 1C

In many service systems (e.g. emergency departments and call centers), the arrival rate tends to fluctuate throughout the day, which complicates personnel capacity decisions. Our research aims to make contributions with regard to the selection of the appropriate shift schedule in an emergency department (ED), with a particular focus on the complexities that arise due to the time-varying nature of the demand for service at the ED. Since the length of the patients waiting time is an important performance metric in the ED, the main emphasis lies on controlling excessive waiting times throughout the day. Due to the small-scale nature of an ED (as opposed to, e.g., a call center), adding or removing 1 unit of capacity can have a large impact on performance.

We present an approach to determine the minimal cost shift requirement in a small-scale service system, taking into account both performance constraints (i.e. the probability of experiencing an excessive waiting time should be small enough at all times) and shift constraints (e.g. shift length and staffing interval). The performance of a given schedule is explored through simulation, whereas the solution space (containing all possible shift schedules) is explored efficiently by means of a branch-and-bound algorithm. Preliminary results indicate that the approach is effective for both small (1-5 servers) and medium-size systems (100 servers), although the computational effort increases substantially as the system size grows.

4 - Medical doctor staffing and scheduling **THU-5C**

Bernardo Almada-Lobo (Universidade do Porto)
Carlos Gomes, José Rui Branco, Manuel Melo, José Luís Borges

Thursday 5C | 09:00 - 10:30 | Carré 1C

This paper addresses the problem of optimizing personnel scheduling in a top tier Portuguese hospital, covering several professional categories: doctors, nurses, technical and auxiliary staff (over five thousands of workers). The project arose from a governmental measure imposing a reduction of 20% on the extraordinary time worked by hospital staff.

The healthcare staff scheduling related literature is mostly concerned with the nurse rostering problem, few papers arise tackling the doctor scheduling. This is mainly due to a mixture of conditions within the doctor working environment, such as the existence of different contract types, working hours, activities and working flexibility among the different hospital services. For instance, in our case study the use of shifts, as it is standard in the nurse working environment is not a feasible solution to doctors. The combination of different time blocks needs to be performed in order to manage the constraints complexity. We propose a quite general mathematical integer linear formulation, considering all the legal and organizational constraints, solved by a state-of-the-art MIP solver. This model takes into account (and penalizes) the changes that these new schedules will have on each person. We first present a diagnosis of the current situation of our case study. Computer experiments are then shown, proving the feasibility of reducing extraordinary work, which, together with a workforce level reduction may allow achieving the governmental goal.

MIRA - Top technology for patients THU-K4

Vinod Subramaniam (University of Twente)

Thursday K4 | 11:00 - 11:45 | Waaier 2

Fundamental biomedical science and advanced technologies are the catalysts for innovation in healthcare. Within MIRA, the University of Twente's institute for biomedical technology and technical medicine, we span the entire chain from fundamental biomedical science to applied research and finally, clinical practice. This unique scientific approach stimulates a successful application of fundamental concepts and enables the rapid translation of scientific and technological innovations to the patient. MIRA works closely with hospitals, the business community and governmental organizations, aiming to secure its leading position in Europe.

Our multidisciplinary approach enables us to make innovative contributions across a wide spectrum within healthcare. MIRA focuses on three strategic research areas - Imaging & Diagnostics, Tissue Regeneration, and Neural and Motor Systems. Examples of MIRA research include fundamental work on neurodegenerative diseases, development of new technologies for bone and cartilage regeneration, and advanced, patient-focused, rehabilitation technologies.

This presentation will touch upon recent scientific and technological advances from the institute that impact healthcare. We will also introduce the Experimental Centre for Technical Medicine (ECTM), key infrastructure for our unique Technical Medicine educational program. ECTM offers state-of-the-art simulation technology for research, development and the education of students and professionals in healthcare, and provides a unique learning space in which the authentic professional environment is simulated. A guided tour of ECTM is offered after lunch.

1 - MetSim: A simulation support tool using meteorological information to improve the planning and management of hospital services THU-6A

Paul Harper (Cardiff University)
John Minty, Bernard Baffour, Sujit Sahu, Christophe Sarran

Thursday 6A | 13:00 - 14:30 | Carré 1B

Improved short-term predictions of hospital admissions and bed occupancy offer the potential to plan resource needs more accurately and effectively. The MetSim project explores the relationship between weather and health, building novel Bayesian models that are more sensitive to fluctuations in weather. Short-term forecasts of the numbers of admissions, categorised by age, gender and medical condition, are produced. In turn, coupled with predictions on length of stay and information on current occupancy, MetSim uses hazard ratios embedded within a simulation framework to provide forecasts of short-term bed needs.

MetSim is a collaboration between Cardiff University, the University of Southampton, and the Met Office. Cardiff and Vale University Health Board and Southampton University Hospitals NHS Trust have guided the development of MetSim, provided data and piloted the tool.

2 - Development of a hybrid grey-fuzzy methodology to forecast future demand for long-term care THU-6A

Philip Worrall (University of Westminster/NHS London Procurement Programme)
Thierry Chaussalet

Thursday 6A | 13:00 - 14:30 | Carré 1B

Long-term care (LTC) consists of the health and social care services that are provided to patients with complex needs which may have arisen due to chronic illness, physical or mental disability. In the majority of cases, LTC patients are typically aged 65 and above and may require care in an institution or community setting. Given long lengths of stay (LoS) and expensive treatment and support costs, LTC represents a significant fraction of many international healthcare budgets. Projections of future demand and cost are crucial in supporting LTC planers commission services, particularly when there is uncertainty with respect to the impact of changes in social and demographic trends, yet existing methodologies frequently require data beyond the scope of the data collected in LTC and gives rise to barriers to their adoption in industry. Grey systems theory has been shown to provide reliable and robust forecasting in a number of situations in which little data is available. Similarly, fuzzy logic lends itself to problems in which demand has nonlinear and uncertainty factors. In this paper we present an investigation into the suitability of using a hybrid Grey-Fuzzy forecasting methodology to predict future levels of LTC demand and cost using routinely collected data from LTC activity in London. Our results are based on data on formal LTC in two London regions between 2008 and 2009. We find that grey-fuzzy modelling can outperform traditional industrial techniques in a number of cases and identify areas for future work.

3 - Forecasting post-surgical length of stay using phase-type distribution and regression tree theory **THU-6A**

Valérie Dorval (Université Laval/CIRRELT)
Angel Ruiz, Patrick Soriano

Thursday 6A | 13:00 - 14:30 | Carré 1B

Our project focuses on the study of bed management, particularly post-surgical hospitalization time after a surgery. Hospitalization beds are often the bottleneck limiting the number of surgeries executed in an operating theatre. However, there is no effective bed management applied in our partner establishment. Indeed, there is no planning or forecasting tool available to manage the bed occupancy. Without this type of tool, it is hopeless to anticipate the availability of beds or to manage adequately the resources between elective and emergency cases or, eventually, between the different specialties.

The aim of this project is to predict the length of stay (LOS) of patients after a surgery. In agreement with our partner establishment, one specialty, orthopaedic surgery, has been selected to build the preliminary model from data over a year. To model the LOS, we chose the phase-type distribution, based on Makov chains theory. This method allows to achieve good results due to its versatility. Moreover, because it is noticed that different factors can affect the LOS of a patient, we used the regression tree theory to refine the model. Taking into account the type of surgery, age of the patient and surgeon, data were separated into different groups. For each of those groups, the phase-type distribution has been estimated. Finally, we used data from the following year to validate our model, noticing better results from the combination of regression tree and phase-type distribution.

4 - Improvement of the inventory management module implemented in a pharmaceutical warehouse management system **THU-6A**

Dhia Jomaa (Université de Lyon/LASPI/Université de Saint-Étienne)
Thibaud Monteiro, Béatrix Besombes

Thursday 6A | 13:00 - 14:30 | Carré 1B

This research is part of an industrial project aiming at improving the performance of a pharmaceutical Warehouse Management System. WMS enables to manage all the operations in a warehouse including the stock level replenishment. This is done by forecasting the future consumption. To make this estimates, the current system uses a moving average. This is a simple method, easy to understand and to implement but usually presents poor accuracy performances. We are interested in this work on the amelioration of the forecasting procedure. We proposed to test a set of more advanced forecasting techniques. We opted for the application of the exponential smoothing and its variants. Known to be robust and simple to implement, these techniques enable to model more complexity in the data including trend and seasonality. To chose between the different methods, a pattern identification procedure was implemented. To compare the performance of these methods to that of a moving average we conducted simulations on data consumption from pharmacies of Lyon hospital in France. We used the mean absolute percentage error to measure the accuracy of the different calculations. Tests showed that the proposed system is slightly more accurate. On average, an accuracy gain of 5,3% was achieved.

1 - Organizing multidisciplinary care for children with neuromuscular diseases THU-6B

Marjan van der Velde (University of Twente)
Nikky Kortbeek, Nelly Litvak

Thursday 6B | 13:00 - 14:30 | Carré 1C

The Academic Medical Center (AMC) in Amsterdam, The Netherlands, recently opened the 'Children's Muscle Center Amsterdam' (CMCA). The CMCA diagnoses and treats children with neuromuscular diseases. These patients require care from a variety of clinicians. Through the establishment of the CMCA, children and their parents will generally visit the hospital only once a year, while previously they visited on average six times a year. This is a major improvement, because the hospital visits are both physically and psychologically demanding for the patients. In this talk, we describe how quantitative modelling supports the design and operations of the CMC. First, an integer linear program is presented that selects which patients to invite for a treatment day and schedules the required combination of consultations, examinations and treatments on one day. Second, the integer linear program is used as input to a simulation to study to estimate the capacity of the CMCA, expressed in the distribution of the number patients that can be seen on one diagnosis day. Finally, a queueing model is formulated to predict the access time distributions based upon the simulation outcomes under various demand scenarios.

2 - Designing appointment schedules in health care: Dealing with walk-in patients THU-6B

Joost Veldwijk (University of Twente)
Aleida Braaksma, Nelly Litvak, Ingrid Vliegen

Thursday 6B | 13:00 - 14:30 | Carré 1C

Traditionally diagnostic facilities schedule appointments for all patients that need consultation. Allowing patients to walk in without an appointment makes it possible for patients to combine outpatient consultations and diagnostic examinations on one day, which speeds up the diagnostic process and reduces access times. Since not all patients can walk in due to capacity restrictions or patient preferences, our goal is to develop an algorithm that generates appointments schedules in which both patients with an appointment and walk-in patients can be served. The generated schedule prescribes the number of appointments to plan per day and the moment on the day to plan these appointments. We maximize the fraction of walk-in patients that can be served, while satisfying an access time service level norm for patients with an appointment. An approach in earlier research generates good schedules for the problem described by using complete enumeration. However, schedules of realistic size cannot be generated since evaluating all solutions is too time consuming. We build on this earlier research, but to achieve computational efficiency we use heuristics that are based on workload levelling and apply local search techniques to improve the schedules found with our heuristics. We apply our approach to a case study of the radiology department of the Academic Medical Center in Amsterdam. Our study shows promising results with respect to the fraction of walk-in patients served on the day of their arrival, the access time of patients with an appointment and the computation time needed to generate good appointment schedules.

3 - Appointment scheduling in presence of seasonal demand **THU-6B**

Evrim Didem Gunes (Koc University)
Tugba Cayirli, Pinar Dursun

Thursday 6B | 13:00 - 14:30 | Carré 1C

This study investigates appointment systems, as combinations of access rules and appointment rules, that are explicitly designed for dealing with walk-in seasonality. In terms of access rules, we assume a portion of capacity is reserved for walk-in demand while the rest is set as the booking limit for apoointments. In terms of appointment rules, strategies are tested to determine which particular slots to leave open for walk-ins. Simulation experiments investigate the effects of environmental factors such as demand load, probability of walk-ins, and seasonality level, on the best access rules and the appointment rules. The performance is measured in terms of patient wait time, physician idle time and overtime and indirect wait time for appointments.

4 - Assessing appointment systems' operational performance with policy targets **THU-6B**

William Millhiser (Baruch College)
Emre Veral, Bendetto Valenti

Thursday 6B | 13:00 - 14:30 | Carré 1C

We propose a paradigm shift in how the performance of outpatient clinic appointment schedules is evaluated in practice and academia. Our research addresses the traditional dilemma between patients' wait times and providers' idle and overtime, but with operational performance metrics that assess their respective probabilities of exceeding established thresholds, instead of optimizing a presumed cost function. Using stochastic modeling we introduce a new way of analyzing appointment schedules that is absent from the literature but appealing to practitioners. We take into account the variable nature of patient consultation times, known differences in the duration of diverse consults, and patients' propensity to miss their appointments. Analysis shows that traditional scheduling systems have serious shortcomings in terms of providing consistent service levels, and we conclude that the managerial decision space so far investigated in the appointment scheduling literature is not adequate for exercising operational control over appointment system performance.

1 - A simulation study of an integrated emergency post THU-7A

Martijn Mes (University of Twente)
Ingrid Vliegen, Renske Visser

Thursday 7A | 15:00 - 16:30 | Carré 1B

In the Netherlands, people with an acute need for care outside regular office hours are often confused where to go: to an emergency department (ED) or to a general practitioners post (GP post). As a result, the ED receives self-referring patients could have been helped by a GP, but since they already are at the hospital, their need for care is satisfied at the ED. One specific initiative to reduce the pressure on EDs, is the use of an Integrated Emergency Post (IEP), which is a collaboration between an ED and a GP post. This paper discusses the development of a discrete-event simulation model for an IEP located at Ziekenhuisgroep Twente (ZGT), in Almelo, The Netherlands. The model was developed with two objectives. First, to be able to benefit the most from this collaboration, in terms of cost efficiency and quality of service, several organizational interventions will be tested using simulation. Second, simulation will be used to provide insight into the benefits of using an integrated emergency post for various hospitals. In addition, the simulation study greatly enhanced the understanding of health care managers of the integrated emergency post and how patient flow is influenced by process changes and resource availability. In this paper we present the simulation model, the verification and validation of this model, and some experimental results.

2 - Planning the patient transport as part of the German EMS system THU-7A

Melanie Reuter (Karlsruhe Institute of Technology)
Stefan Nickel

Thursday 7A | 15:00 - 16:30 | Carré 1B

In Germany, the federal states have sovereignty over the Emergency Medical Service (EMS) system. Therefore, each state has its own EMS law including different rules and specific definitions of the provided services. Each state is then divided into smaller EMS regions with a rescue coordination centre being responsible for the allocation and organisation of the services.

EMS systems in Germany are not only responsible for emergency services but also for the transport of patients if the attendance of an emergency medical assistant is necessary. Even if many of the transportation demands are known in advance, trips are usually not planned at present, if anything then they are planned manually. One of the main problems is the waiting times for the patients. We want to show that by modelling it as a dial-a-ride problem and using an online heuristic to include short-term demands, scheduling the patient transportations can be reasonable in practice. Due to cost increases and cost pressure which are typical for the healthcare sector efficient planning methods become more and more important.

We present a mathematical model and an algorithm for solving the patient transportation problem. We test these using data from a rescue coordination centre located in the south of Germany.

The long-term goal is to build a platform that connects the EMS regions within a federal state. It integrates the ability to schedule patient transports between different regions to avoid empty trips on the way back.

3 - Using data mining and simulation for health system understanding and capacity planning: an application to urgent care **THU-7A**

Thierry Chaussalet (University of Westminster)
Mohamed Tadjer, Farid Fouladinejad, Salma Chahed

Thursday 7A | 15:00 - 16:30 | Carré 1B

Many visits to Accident and Emergency are made for problems that do not require emergency interventions. Care for non urgent cases is more costly in the A&E than in primary care settings. Various methods have been used in attempts to decrease non urgent A&E use. Often, triaging method is used to redirect patient with non urgent care problems to primary care facilities. This method requires health professionals to assess the urgency of the patient's problem before determining whether ED care is appropriate.

The purpose of this study is to assist Hillingdon Primary Care Trust examine their Accident and Emergency services and to help improving health access by redesigning these services into two different settings, Urgent Care Centre (UCC) and Emergency Department (ED). This study used data mining techniques to understand system behaviour in terms of subsystem interactions and the factors influencing patient flows. The insight obtained through Clustering analysis and Association Rules mining are then used as patients demand and pathways supporting better services in the UCC. The data have been clustered into groups and sub groups on their resources used and acuity. These groups are the identified target groups for service specification strategy design and decision making. We used simulation modelling to help understanding the correlations that exist between various inputs into a UCC (i.e., capacity and resources, facility and staff resources) and various output performance measures from the system (i.e., patient waiting times, staff utilisation, resources and facility utilisation).

4 - A multi-criteria decision model for the evaluation of emergency department performance **THU-7A**

Serhat Tüzün (Yildiz Technical University)
Ilker Topcu

Thursday 7A | 15:00 - 16:30 | Carré 1B

Emergency Department Performance (EDP) is a research area that has not been studied in detail yet. Studies about Emergency Department (ED) are under the opinion that a generalized performance evaluation is hard to apply in ED, since it has a very high level of uncertainty. In this context, studies are handling the important factors of ED separately to calculate efficiency based on one factor. This study aims to provide a general performance evaluation of ED by uniting these factors under a model.

To calculate the EDP, ten criteria under three main criteria are derived from the important factors. Weights of these factors affecting EDP and the performance values of each criterion are used to obtain a formulation. A two-phased model is formed to calculate EDP using this formulation. First, importance level of each criterion is calculated by determining relations between the criteria and levels of these relations using Analytic Network Process. Weights are evaluated using these importance levels. Then, evaluation measure of each criterion is transformed into performance values through Performance Transformation Functions.

The proposed model is applied to an ED of a major hospital located in Istanbul. Weights are determined as a result of the meetings held with healthcare experts, and performance values of the criteria are evaluated from the measurements in the ED. Overall performance value of the application area is calculated by the combination of all these data using the formulation of EDP, and strengths and weaknesses of the ED are determined.

1 - The optimal allocation of server time slots over different classes of patients

THU-7B

Stefan Creemers (IESEG School of Management)
Jeroen Beliën, Marc Lambrecht

Thursday 7B | 15:00 - 16:30 | Carré 1C

We present a model for assigning server time slots to different classes of patients. The objective is to minimize the total expected weighted waiting time of a patient (where different patient classes may be assigned different weights). A bulk service queueing model is used to obtain the expected waiting time of a patient of a particular class, given a feasible allocation of service time slots. Using the output of the bulk service queueing models as the input of an optimization procedure, the optimal allocation scheme may be identified. For problems with a large number of patient classes and/or a large number of feasible allocation schemes, a step-wise heuristic is developed. A common example of such a system is the allocation of operating room time slots over different medical disciplines in a hospital.

2 - An efficient decomposition approach for surgical planning

THU-7B

Marco Pranzo (Università di Siena)
Alessandro Agnetis, Alberto Coppi, Matteo Corsini, Gabriella Dellino, Carlo Meloni

Thursday 7B | 15:00 - 16:30 | Carré 1C

This talk presents an efficient decomposition approach to surgical planning. Given a set of surgical waiting lists (one for each discipline) and an operating theater, the problem is to decide the room-to-discipline assignment for the next planning period (Master Surgical Schedule), and the surgical cases to be performed (Surgical Case Assignment), with the objective of optimizing a score related to priority and current waiting time of the cases. While in general MSS and SCA may be concurrently found by solving a complex integer programming problem, we propose an effective decomposition algorithm which does not require expensive or sophisticated computational resources, and is therefore suitable for implementation in any real-life setting.

Our decomposition approach consists in first producing a number of subsets of surgical cases for each discipline (potential OR sessions), and select a subset of them. The surgical cases in the selected potential sessions are then discarded, and only the structure of the MSS is retained. A detailed surgical case assignment is then devised filling the MSS obtained with cases from the waiting lists, via an exact optimization model.

The quality of the plan obtained is assessed by comparing it with the plan obtained by solving the exact integrated formulation for MSS and SCA. Nine different scenarios are considered, for various operating theater sizes and management policies. The results on instances concerning a medium-size hospital show that the decomposition method produces comparable solutions with the exact method in much smaller computation time.

3 - Robust master surgical scheduling **THU-7B**

Malek Masmoudi (LASPI/L'Institut Universitaire de Technologie de Roanne)
Said Kharraja

Thursday 7B | 15:00 - 16:30 | Carré 1C

The operating theatre (OT) is one of the most critical and expensive resources in a hospital, due to its impact on healthcare costs and quality of service (Hall, 2006). The OT managers are faced with complex decision problem at the tactical level: assigns surgical disciplines to Operating Rooms (OR) sessions over time, thus obtaining the so called Master Surgical Schedule (MSS) (Agnetis et al., 2012). This paper deals with MSS problem within private French hospitals. We focus on the Block Scheduling Strategy (BSS) i.e. time sub-slots, called also Block Times (BT), are allotted to surgeons or surgical groups (SG) according to their availabilities and daily/weekly requirements (Kharraja et al, 2006). We propose a mixed integer programming model to provide a robust MSS for several weeks within a proactive approach. Numerical results are given to show the performance of the model.

4 - Capacity planning in operating rooms by means of centralized data envelopment analysis: Case study of Alzahra hospital in Isfahan-Iran **THU-7B**

Marzieh Soltanolkottabi (Isfahan University of Technology)
Saeedeh Ketabi

Thursday 7B | 15:00 - 16:30 | Carré 1C

In recent years providing health services to patients has becoming increasingly important and countries spend a large number of their GDPs on health services. In this environment application of managerial approaches will lead to the more efficient use of resources. Hospitals absorb a large share of public health expenditures; therefore, considerable savings in health cost can be achieved through the improving their efficiency. Since operating theatre has the hospitals largest cost and revenue, it has significant role in the performance of the hospital as a whole. In the past decades, a large body of literature on the management of operating theaters has evolved. One field that is of particular interest is operating room (OR) planning. The first phase in OR planning is to determine the number of OR times allocated to each surgical service.

In this study, centralized data envelopment analysis is used to allocate the limited resource of OR times to different surgical services. We considered that there is a centralized decision maker (Operation theatre manager) who supervises all the surgical services. This centralized OR capacity planning model, while interested in the efficiency of the services, is also concerned with the overall consumption of the different inputs and the overall production of their outputs. It is also shown by the centralized DEA model how extra OR blocks can be assigned to the surgical services. The model has been solved for data of operating theatre of Alzahra Hospital in Isfahan, Iran. The data has been collected in autumn, 2011.

Friday July 20th

09:30	Session 8		
	8A Process Optimization *Room: Carré 1A*	**8B Emergency Care Services (2)** *Room: Carré 1B*	**8C Planning Health Services** *Room: Carré 1C*
	Mehmet Begen (p80) Reducing wait times and improving treatment planning process for radiation therapy	**Vincent Knight (p82)** A game theoretical approach to the Emergency Medical Vehicle - Emergency Department interface	**Teresa Cardoso (p84)** Searching for equity improvements: A multi-objective mathematical programming model for planning the delivery of long-term care
	Marek Lubicz (p80) Towards supporting clinical, hospital, and regional management-lessons from thoracic surgery	**Geert Jan Kommer (p82)** Optimal ambulance capacities under uncertain demand and response times	**Mario Jorge Ferreira de Oliveira (p84)** An operations and control center for rescue and treatment of emergency patients in large scale events
	Claude Olivier (p81) Analysis of emergency departements in a regional hospital: A lean approach	**Leanne Smith (p82)** Allocating EMS vehicles to maximise survival of heterogeneous patients	**Christos Vasilakis (p85)** The Surgical Wound Infection Monitoring (SWIM) tool
	Mohammad Yarmohammadian (p81) Improvement of hospital processes through Business Process Management (BPM) in Qaem teaching hospital: A work in progress	**Rob van der Mei (p83)** TIFAR: A simulation tool evaluating dispatching strategies for ambulance services	**David Stanford (p85)** Addressing waiting time inconsistencies in transplantation
11:00	Coffee/Tea		*Room: Foyer Waaier*
11:30	Business Meeting		*Room: Waaier 2*
12:30	Lunch		*Room: Foyer Waaier*

1 - Reducing wait times and improving treatment planning process for radiation therapy **FRI-8A**

Mehmet Begen (Western University)
Inge Aivas, Vusal Babashov, Michael Lock, Gregory Zaric

Friday 8A | 09:30 - 11:00 | Carré 1A

According to Cancer Care Ontario (CCO), the referral to consult duration (RTC, the duration between a referral to a specialist to the time that specialist sees the patient) and the ready to treat (RTT, the time when the specialist is confident the patient is ready to begin treatment) to treatment wait times targets must be fulfilled within 14 calendar days. Recent CCO statistics show that London Regional Cancer Program (LRCP) consults 65% and treats 70% of patients within the target times.

We studied the radiation treatment planning process from patient referral to treatment at LRCP. We analyzed available data from hospital administration databases, interviewed stakeholders and observed processes. We prepared a process map of the radiation treatment planning and developed a discrete event simulation model to determine possible bottlenecks and reduce wait times (RTC and RTT to treatment) at LRCP.

Analysis and results identify possible bottlenecks of the system. Adding one more radiation oncologist decreases RTC wait time. Increasing the available number of treatment slots per given day reduces the RTT to treatment wait time. Adding one more dosimetrist reduces RTT time. The changes in number of other resources do not have a significant effect on wait time. Amongst the tested scenarios, an extra radiation oncologist has the most beneficial impact resulting in more patients treated and a decrease in overall RT planning time. A long term goal is to find the most cost effective ways to satisfy COO wait time targets and continuously improve and redesign the system.

2 - Towards supporting clinical, hospital, and regional management-lessons from thoracic surgery **FRI-8A**

Marek Lubicz (Wrocaw University of Technology)
Maciej Ziba, Adam Rzechonek, Konrad Paweczyk, Jerzy Koodziej, Jerzy Sypua

Friday 8A | 09:30 - 11:00 | Carré 1A

Decision problems arise at different levels of healthcare systems, some of them being common (scheduling) and others - being specific to some clinical technologies (robotic surgery) or domains (oncology). In addition to High Tech developments in clinical areas (drugs, equipment, surgical know-how), there are High Tech developments in quantitative approaches, proposed for problem solving and decision support in healthcare management (phase-type distributions, agent based simulation), or in general data processing or modelling fields (machine learning, computational intelligence). More specificity is observed at particular levels of decision making: clinical, hospital, and regional decisions need particular details and specific approaches in problem structuring, model formulation and solving, but above all, in validating and implementing recommendations.

We present lessons learned from a collaborative project in Thoracic Surgery management, as seen from the three levels of management by clinicians from Lower Silesian Thoracic Surgery Centre, public officers of the Regional Health Authority and the Regional Sickness Fund, as well as academics from Wrocaw University of Technology, Poland.

Machine learning approaches to supporting clinical management questions (what shall be done; when; to whom; what shall be avoided) are discussed for highly imbalanced data sets

with missing values. The data mining results are confronted with clinicians implementation expectations, but also with current financing mechanisms and resource allocation procedures at hospital and at regional level.

Concluding remarks concern usefulness of applying advanced machine learning or formal allocation models for supporting solving healthcare management questions, and for implementing the results of modelling for the benefit of patients.

3 - Analysis of emergency departements in a regional hospital: A lean approach **FRI-8A**

Claude Olivier (Université du Québec)
Marie-Claude Boudreau

Friday 8A | 09:30 - 11:00 | Carré 1A

This paper describes the application of the lean methodology to an Emergency Department (ED) in a regional hospital working as a network. The lean approach was used to reduce the number of patients on stretcher and the length of stay in the ED. It also aims to improve the flow of patients to other care units. The specific aspects of this study are related to different factors, particularly the hospital size and organizational structure.

The hospital is the main institution of a CSSS, a governmental organization to deliver healthcare and social services to specific region. Physically, structural and operational organization of this CSSS is also different. It is a network of several institutions having specific vocations on a distance of more than 200 kilometers along the Atlantic coast and serving approximately 40,000 people. The main hospital ED has a second emergency located approximately 90 km away. However, technical facilities are limited; several patients are transferred to the main emergency after being stabilized. This organization greatly increases the main ED overcrowding.

The paper will present the current context, the actual process and value stream, the identification of bottlenecks and solutions deployed to improve the operation. Quantitative results will be shown.

4 - Improvement of hospital processes through Business Process Management (BPM) in Qaem teaching hospital: A work in progress **FRI-8A**

Mohammad Yarmohammadian (Isfahan University of Medical Sciences)
Hossein Ebrahimi, Farzane Dousti

Friday 8A | 09:30 - 11:00 | Carré 1A

Business process management (BPM) is a holistic management approach which promotes business effectiveness and efficiency while striving for innovation, flexibility, and integration with technology, so described as a "process optimization process". An empirical study by Vera & Kuntz (2007) conducted in the German hospital sector indicates that BPM has a positive impact on organizational efficiency. The purpose of the study is to improving selected hospital processes by applying BPM ina teaching hospital (Qaem) affiliated to a medical university, Mashhad,Iran. Instruments of the study was observations, interviews as well as discussion via some focus discussion groups FDGs. This research designed in 4 phases including;1) identifying selected processes and priorities, 2)modeling for the selected processes, 3)modification, and improvement of the processes,and finally 4) concluding and finalization of improved processes.

1 - A game theoretical approach to the Emergency Medical Vehicle - Emergency Department interface **FRI-8B**

Vincent Knight (Cardiff University)

Friday 8B | 09:30 - 11:00 | Carré 1B

At the forefront of any healthcare system are two interacting services: the Emergency Medical Services (EMV) service and the Emergency Department (ED). Often EMVs are subject to long delays at a particular ED whilst the ED suffers from upstream congestion due to arrivals of other patients. In this work, a game theoretical model is given. The EDs strategies correspond to the allocation of resources throughout the hospital whilst the EMV service is modelled as a routing game. Various insights are given that inform as to optimal levels of policy regulation.

2 - Optimal ambulance capacities under uncertain demand and response times **FRI-8B**

Geert Jan Kommer (National Institute for Public Health and the Environment)
Barbora Zuzáková, Sandjai Bhulai

Friday 8B | 09:30 - 11:00 | Carré 1B

We describe an ambulance location optimization model that maximizes coverage provided by ambulance vehicles. The model measures service level as the fraction of calls reached within a given time standard and considers response time to be composed of a random pre-trip delay, prior to travel to the scene, plus a normally distributed travel time. In addition to modelling the uncertainty in the response time, we incorporate uncertainty in the ambulance availability by modelling the busy time of ambulance. We also incorporate the budget constraints for maintaining the vehicles and stations. Risk is defined in relation to pre-trip uncertainty together with the uncertain availability of ambulances. The model is worked out for the region of Amsterdam in the Netherlands. Data of the ambulance service in 2010 are analysed and used to estimate several distributions of parameters for the model. The model allows determining the number and geographical dispersion of ambulances, given a pre-defined coverage of risk.

3 - Allocating EMS vehicles to maximise survival of heterogeneous patients **FRI-8B**

Leanne Smith (Cardiff University)
Vincent Knight, Paul Harper

Friday 8B | 09:30 - 11:00 | Carré 1B

An effective ambulance service is an essential part of a health care system. The objective of any such service is to save lives by reaching critical patients in a minimum amount of time. This paper proposes new models for locating Emergency Medical Service (EMS) vehicles in order to maximise the overall expected survival probability of multiple-classes of patients. The Maximal Expected Survival Location Model for Heterogeneous Patients (MESLMHP) defines different patient classes according to agreed patient categories, or by capturing differing medical conditions each with a corresponding survival function. Furthermore, an approximation approach to MESLMHP solves the issues of congestion and utilisation at ambulance stations. Both models can be used to show that multiple outcome measures and the survival-maximising approach provide more effective EMS operations based on the resulting vehicle allocations.

4 - TIFAR: A simulation tool evaluating dispatching strategies for ambulance services **FRI-8B**

Rob van der Mei (Centrum Wiskunde & Informatica)
Martin van Buuren

Friday 8B | 09:30 - 11:00 | Carré 1B

Ambulance services are an important part of society. In life-threatening emergency situations, the ability of ambulance service providers to arrive at the emergency scene within a few minutes to provide medical aid may make the difference between survival or death. In practice, commonly used service-level target is that the response time for high-emergency calls should be less than x minutes in y% of the cases. To realize short response times at affordable cost, efficient planning of ambulance services is crucial.

A highly promising means to improve the efficiency of ambulance services is to implement pro-active dispatching and relocation policies, forcing ambulance vehicles to be relocated in order to maintain good coverage of the service area. Despite the fact that such dynamic ambulance management (DAM) policies are highly promising, only little is understood today about the implications of implementing DAM on the performance of ambulance services in practice.

In this presentation we will discuss the so-called Testing Interface for Ambulance Research (TIFAR) decision support tool that can be used to evaluate dynamic dispatch strategies. To validate the accuracy TIFAR is tested on the real-life data for the region of Amsterdam, the Netherlands. The results show that the TIFAR-based performance predictions are highly accurate.

1 - Searching for equity improvements: A multi-objective mathematical programming model for planning the delivery of long-term care FRI-8C

Teresa Cardoso (Technical University of Lisbon)
Mónica Oliveira, Ana Barbosa-Póvoa, Stefan Nickel

Friday 8C | 09:30 - 11:00 | Carré 1C

Several European countries are facing an increasing demand for Long-Term Care (LTC), mainly due to the ageing phenomenon and to the increase in the prevalence of chronic diseases. Satisfying this increasing demand requires an adequate supply of services, which is still low in many countries. Although many countries across Europe are currently facing severe budget cuts and lack funding to develop the supply of these services, planning the supply of LTC is currently a health policy priority in many European countries. In particular, in countries based on a National Health Service (NHS) structure this planning must take into account the available budget, as well as the pursuit of equity in the services provision. This study aims to address this planning problem and proposes a multi-objective mathematical programming model to inform decisions regarding the LTC capacity required to meet the need for services, where to invest and where to locate such capacity, given the available budget and while pursuing equity in the provision of services. Capacity is translated into beds for institutional care, vehicles for home-based care, and professionals for home-based, ambulatory and institutional care. The model also informs on how to distribute this capacity across services and patients groups over time. Three equity measures are pursued within the model, namely, two measures of geographical equity and one measure of socioeconomic equity. Results from applying the model to the Lisbon and Tagus Valley Administrative Region in Portugal are obtained, showing how to prioritize investments in the provision of LTC.

2 - An operations and control center for rescue and treatment of emergency patients in large scale events FRI-8C

Mario Jorge Ferreira de Oliveira (Federal University of Rio de Janeiro)
Fabio Oliveira, Delana Oliveira, Waleska Chaves

Friday 8C | 09:30 - 11:00 | Carré 1C

This article proposes the creation of an Operations and Control Center to enable the integration between the various services involved in the rescue and treatment of emergency patients. The main features are: the first emergency care, the monitoring of the critical cases, the risk classification scheme and the referring patients to the appropriate hospital sectors.

In view of the urban and natural disasters that are happening everywhere and the two big events that are about to happen in the city of Rio de Janeiro in 2014 and 2016, this study points to the problem of imbalance between the provision of pre-hospital rescue, medical services in emergency hospitals and manpower to accommodate situations where there is an unexpected increase in demand.

The Pre-hospital Care is the most important step in the rescue of an emergency and can be determined as the assistance provided in a first level of care for patients diagnosed as acute, clinical, psychiatric or traumatic, when they occur in the environment outside the hospital. A detailed model is developed to simulate the rescue operations carried out by the Mobile Emergency Care, in order to determine estimates of performance parameters. Several options are evaluated to set the operation, in order to reduce response time.

The hospital emergency care is critical to maintaining the quality of services provided. A large scale simulation model is developed to evaluate aspects of the flow of patients in four

municipal hospitals of the city of Rio de Janeiro. The proposed model aims to eliminate major bottlenecks and evaluate the capacity of the resources involved. The main parameters are: size of the queue, queuing time, number of patients seen and utilization rate of resources. The model considers the flow of high complexity patients and evaluates various scenarios in order to see how the system responds to increased demand.

3 - The Surgical Wound Infection Monitoring (SWIM) tool **FRI-8C**

Christos Vasilakis (University College London)
Peter Wilson, Fares Haddad

Friday 8C | 09:30 - 11:00 | Carré 1C

We present the Surgical Wound Infection Monitoring (SWIM) software tool specifically developed to support the monitoring and reporting of the occurrence of surgical wound infections in hospitals. The tool uses data collected routinely by a London teaching hospital as part of its infection surveillance system, which includes post-discharge follow-up. Based on these data, the tool is used to generate graphs showing cumulative infections over time and variable life-adjusted display (VLAD) charts that account for the expected specialty average infection risk. The user can select, along with other options, the definition of infection used in the preparation of the graphs. Using an illustrative example of wound infection monitoring in orthopaedic surgery, we demonstrate the tool and its intended use to trigger further scrutiny rather than draw firm conclusions. We show that the tool has the ability to generate departmental debate, which should ultimately lead to the increased safety of surgical patients. We recommend adopting the tool and VLAD charts wherever surgical site surveillance is continuous.

4 - Addressing waiting time inconsistencies in transplantation **FRI-8C**

David Stanford (University of Western Ontario)
Jung Min Lee, Natasha Chandok, Vivian McAlister

Friday 8C | 09:30 - 11:00 | Carré 1C

Many studies of wait times for transplantation have revealed a common pattern: recipients of blood type O wait on average substantially longer than blood type A, which in turn wait substantially longer than blood type AB. Depending on the circumstances in some cases patients of blood type B wait somewhat longer than O, and in others, somewhat less. This situation arises in many countries for many organ types, and the phenomenon has come to be known as the blood type O problem. Using simple queues as a proxy, I will provide an indication as to what the likely order of magnitude for the wait times would have been in a strict no-cross-transplantation policy was in place. Finally, I will present a hybrid policy in which O-to-B and A-to-AB cross-blood-type transplantation is allowed while the rest are barred, thereby providing access to each patient to roughly half of the available supply. We establish that the fraction of needed cross-transplantations is ensured to be small.

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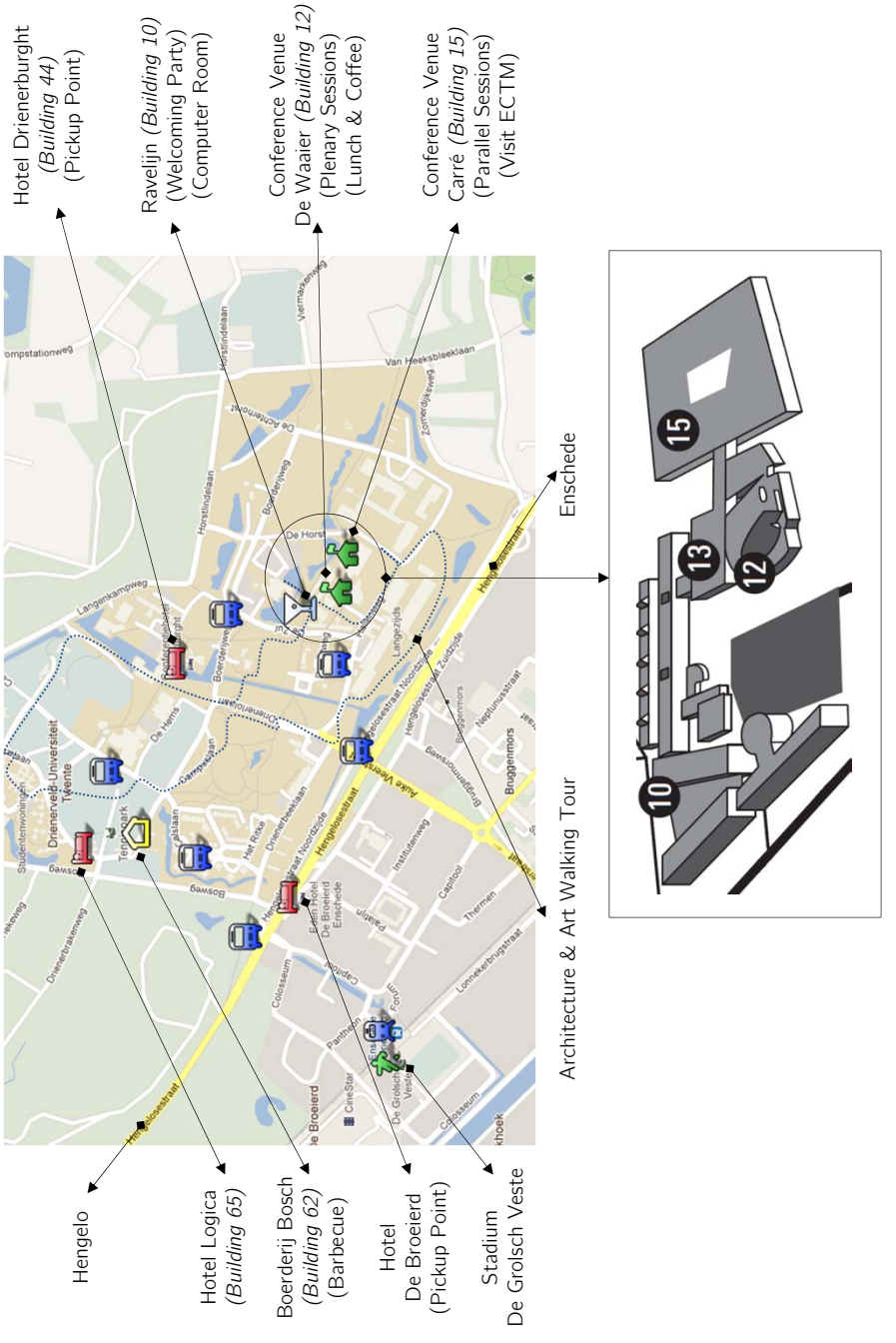
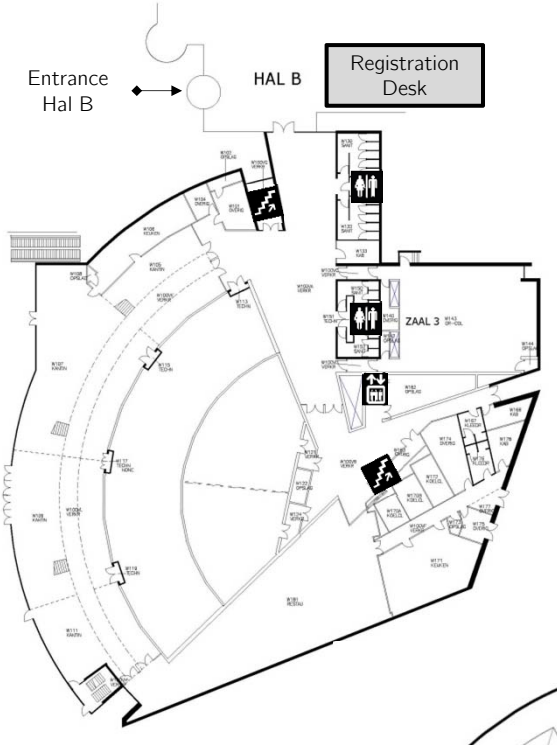
For contact information of the participants of the symposium, we refer to the separate list which you can find in your conference bag.

Maps

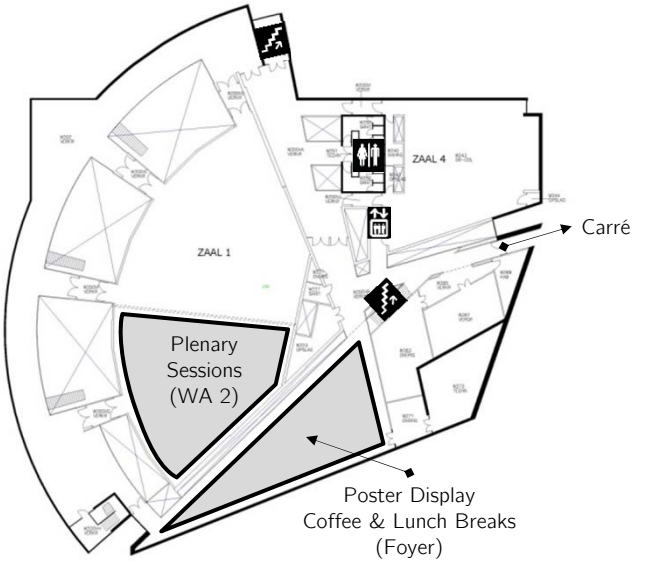
Campus


Hotel Drienerburgh
(Building 44)
(Pickup Point)
Ravelijn (Building 10)
(Welcoming Party)
(Computer Room)
Conference Venue
De Waaier (Building 12)
(Plenary Sessions)
(Lunch & Coffee)
Conference Venue
Carré (Building 15)
(Parallel Sessions)
(Visit ECTM)
Enschede
Architecture & Art Walking Tour
Hengelo
Hotel Logica
(Building 65)
Boerderij Bosch
(Building 62)
(Barbecue)
Hotel
De Broeierd
(Pickup Point)
Stadium
De Grolsch Veste
10
12
13
15

Building Waaier

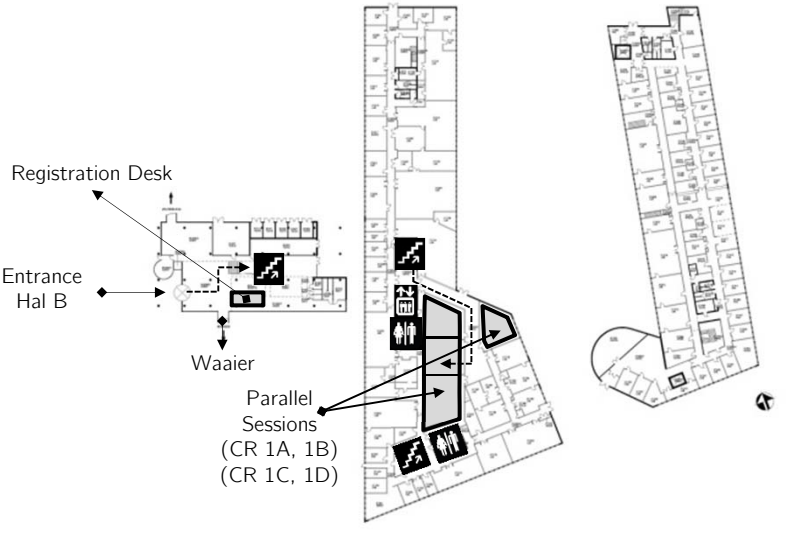


Floor 1

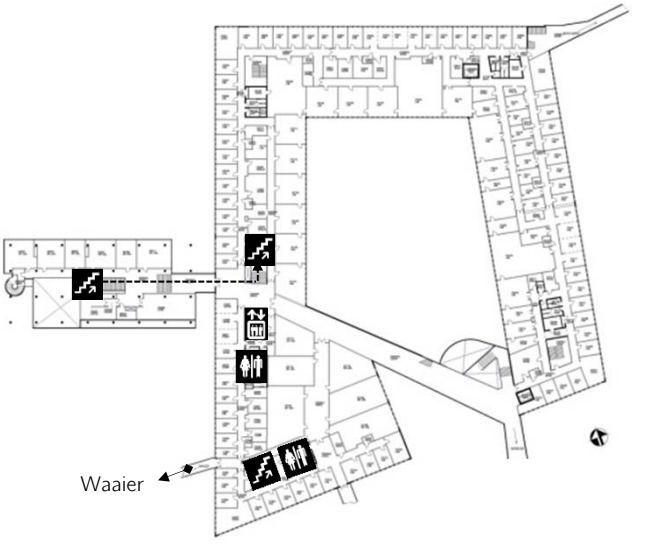


Floor 2

Building Carré

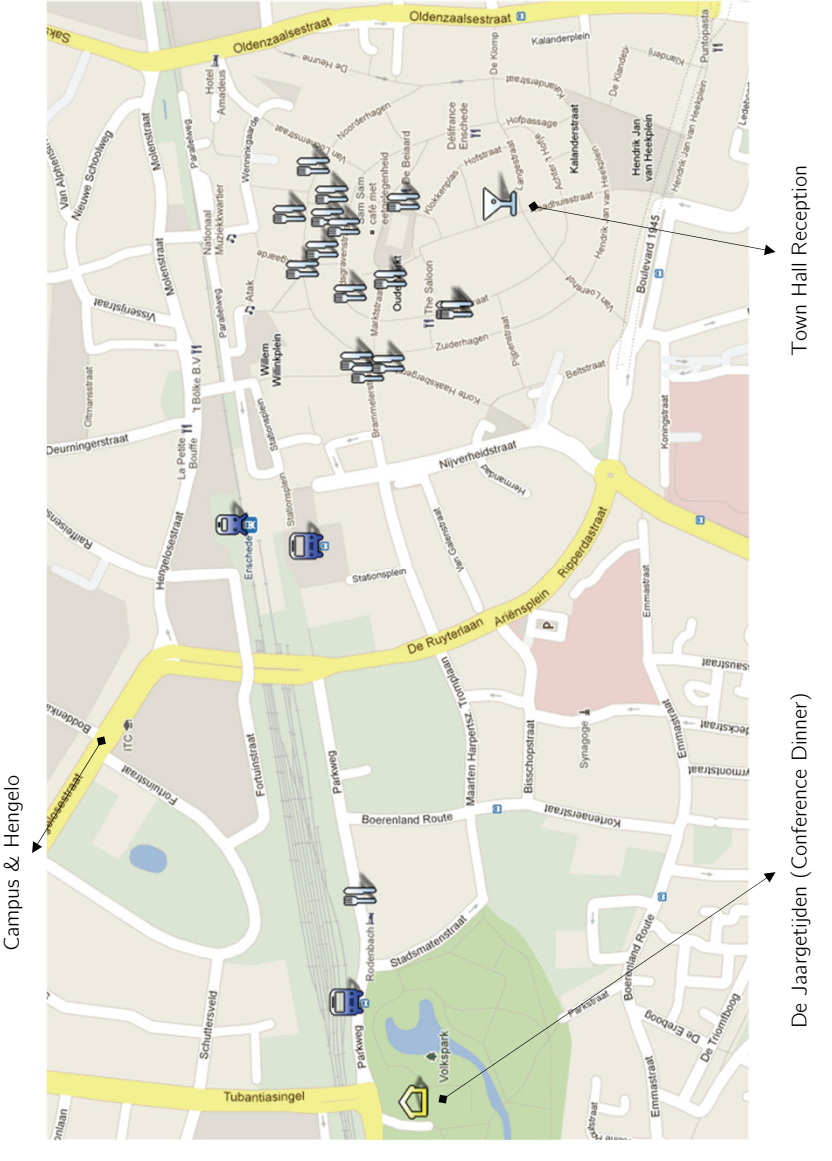


Floor 1



Floor 2

Enschede


Campus & Hengelo
Town Hall Reception
De Jaargetijden (Conference Dinner)
Oldenzaalsestraat
Kalanderplein
Hendrik Jan van Heekplein
Boulevard 1945
Nijverheidstraat
Ripperdastraat
De Ruyterlaan
Ariënsplein
Stationsplein
Enschede
Deurningerstraat
Hengelosestraat
Parkweg
Boerenland Route
Stadsmatenstraat
Tubantiasingel
Volkspark
Fortunastraat
Schuttersveld
Emmastraat
Bisschopstraat
Maarten Harpertszoon Tromplaan
Synagoge
Beltstraat
Zuiderhagen
Noorderhagen
Hofstraat
Hofpassage
Kalanderstraat
Willem Wilinkplein
Molenstraat
Nieuwe Schoolweg
Van Alphenstraat
Wissenlystraat
Oldenzaalsestraat
Koningstraat
Emmastraat
Boulevard 1945
Parkweg
Roderbach
Boerenland Route
Parallelstraat
De Triomfboog
De Erebocht
Korte Haaksbergerstraat
Brammelerstraat
Marktstraat
Langestraat
Pijlenstraat
Van Lovenstraat
Hengelosestraat
Fortunastraat
Parkweg
Schuttersveld
Volkspark
Tubantiasingel
Stationsplein
Van Galenstraat
Nijverheidstraat
Deurningerstraat
Oldenzaalsestraat
Molenstraat
Parallelweg
Nieuwe Schoolweg
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Wissenlystraat
Oltmansstraat
Willem Wilinkplein
Beltstraat
Zuiderhagen
Noorderhagen
Hofstraat
Hofpassage
Kalanderstraat
Hendrik Jan van Heekplein
Boulevard 1945
Koningstraat
Emmastraat
Bisschopstraat
Maarten Harpertszoon Tromplaan
Synagoge

Address List Restaurants

Restaurants in Enschede			
Faculty Club (University of Twente)	Boerderijweg	053 4892399	€€€€
Fellini	Bolwerkstraat 2	053 4363399	€€
De Tropen	Bolwerkstraat 9	053 4345350	€€€
La Roche Steaks & Seafood	Hengelosestraat 200	053 4353855	€€€€
Eetcafe de Fusting	Hengelosestraat 281	053 4304321	€
Eden Hotel de Broeierd	Hengelosestraat 725	053 8506500	€€€€
Los Ponchos (Mexican)	Korte Haaksbergerstraat 2	053 4311787	€€
Turquoise (Turkish)	Korte Haaksbergerstraat 3	053 4309180	€€€
Olympic (Greek)	Korte Haaksbergerstraat 4	053 4309036	€€
Goody's (Steakhouse)	Marktstraat 2	053 4361006	€€
Humphrey's	Noorderhagen 42	053 4837763	€€
C'est Si Bon	Noorderhagen 54 A	053 4310928	€€
Sam Sam	Oude Markt 15-17	053 4303929	€€
Pinoccio (Pizza)	Oude Markt 21	053 4303078	€€
Villa van Heek	Oude Markt 26	053 4308111	€€
La Berry's (Tapas)	Oude Markt 4	053 4304590	€€€
Hotel Restaurant Rodenbach	Parkweg 35	053 4800200	€€€€
Eetcafé Atrium	Stadsgravenstraat 47	053 4300967	€€
Het Kostershoes	Stadsgravenstraat 57	053 4342161	€€
De Ouwe Compagnie	Walstraat 39	053 4308160	€€
ONS Eten & Drinken	Walstraat 41	053 4323293	€€

Restaurants in Hengelo			
De Buurman / De Dragonder	Beursstraat 2	074 2434777	€€€
Stravinsky	Burg. Jansenplein 20	074 2910265	€€€
De Twee Wezen	Burg. Jansenplein 23/24	074 2914045	€€€
De Bourgondier	Langestraat 29	074 2433133	€€€€
Pizzeria Italia	Marktstraat 15A	074 2422431	€€
Ziesta BBQ Restaurant	Marskant 8	074 2433723	€€
De Appel	Nieuwstraat 1	074 2423138	€
Plaza Latina (Mexican)	Stationsplein 41-43	074 2593660	€€€
Akropolis (Greek)	Stationsplein 72	074 2437323	€€
Bombay Spice (Indian)	Wemenstraat 59	074 2433669	€€

Price indication	
€	less than € 17.50
€€	€ 17.50 - € 25.00
€€€	€ 25.00 - € 32.50
€€€€	more than € 32.50