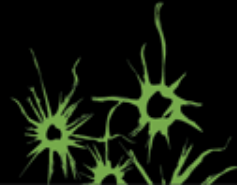


Implementing algorithms to reduce ward occupancy fluctuations through advanced planning

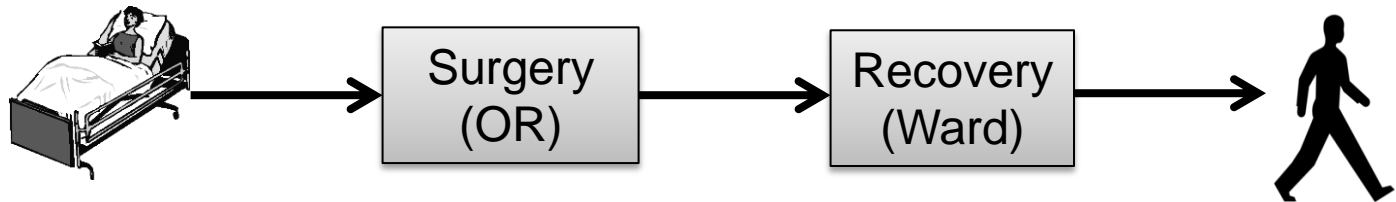
Peter T. Vanberkel, Richard J. Boucherie, Erwin W. Hans,
Johann L. Hurink, Wineke A.M. van Lent, Wim H. van Harten



CHOIR- Center for Healthcare Operations Improvement and Research
Netherlands Cancer Institute – Antoni van Leeuwenhoek Hospital



PROBLEM



Surgical Schedule

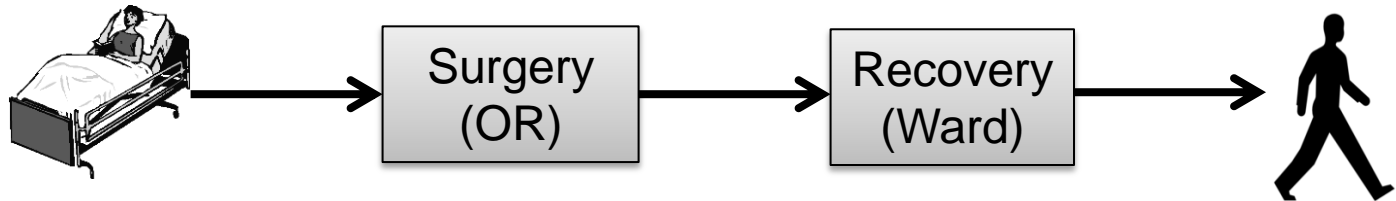
	Mon	Tue	Wed	Thu	Fri
OR1	Chi (KLM)	CHI (VWL)	CHI (vwl/rur) HIPEC	Chi (nie)	Chi (VRP)
OR2	KNO	CHI (RUT)	Urologie (hbs)	RT	Urologie (MND)
OR3	KNO	Plas Chi	KNO	KNO	Plas Chi
OR4	CHI (COR)	Gyne	Chi Mamma	Plas Chi	Gyne
OR5	RT	CHI (SND/WOS)	RT (vwl/rur)	Urologie (pel/bex)	Urologie (P&B)
OR6	Urologie (P&B)	CHI (VWL)	Gyne	Chi (ODB)	Chi (Cor/rur)

Design Questions:

- Which specialty when?
- Which recovery ward?
- ...
- How many “blocks” per specialty?
- Full day or half day blocks?
- ...



PROBLEM



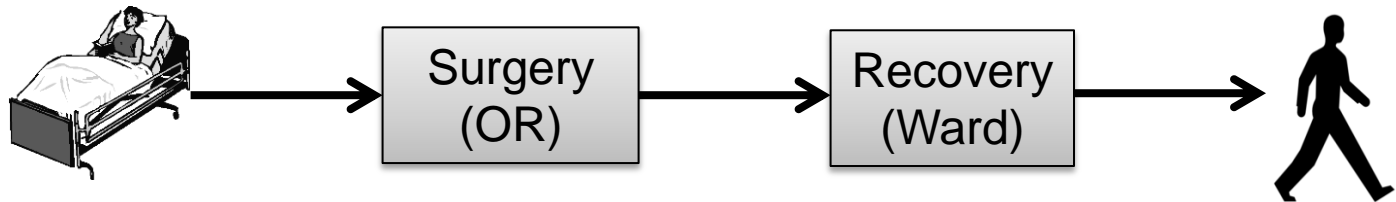
Surgical Schedule

	Mon	Tue	Wed	Thu	Fri
OR1	Chi (KLM)	CHI (VWL)	CHI (vwl/rur) HIPEC	Chi (nie)	Chi (VRP)
OR2	KNO	CHI (RUT)	Urologie (hbs)	RT	Urologie (MND)
OR3	KNO	Plas Chi	KNO	KNO	Plas Chi
OR4	CHI (COR)	Gyne	Chi Mamma	Plas Chi	Gyne
OR5	RT	CHI (SND/WOS)	RT (vwl/rur)	Urologie (pel/bex)	Urologie (P&B)
OR6	Urologie (P&B)	CHI (VWL)	Gyne	Chi (ODB)	Chi (Cor/rur)

Design Challenges:

- Surgeon availability
- Equipment availability
- Impact on the ward(s)

PROBLEM



Surgical Schedule

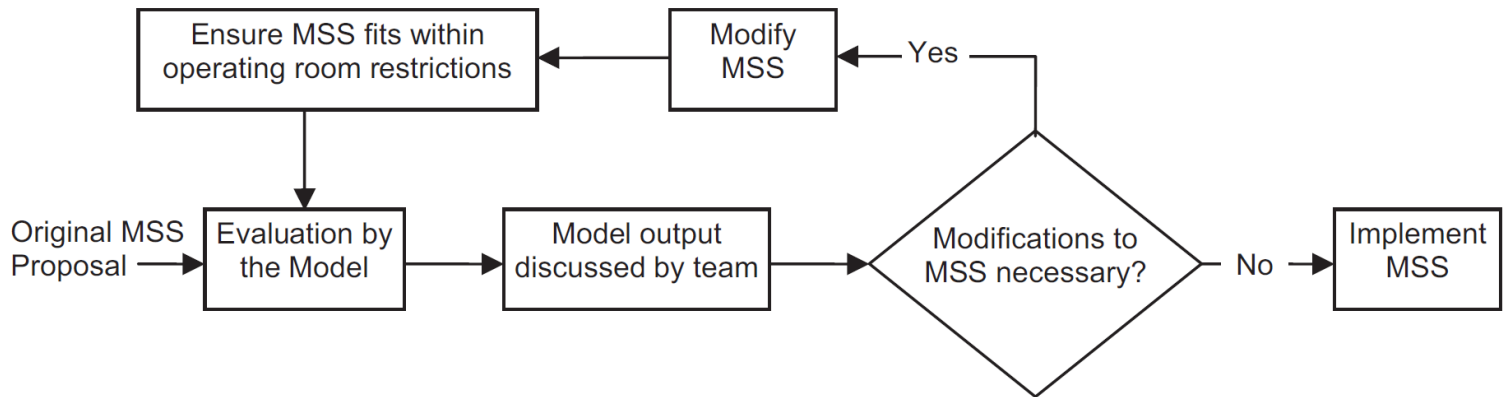
	Mon	Tue	Wed	Thu	Fri
OR1	Chi (KLM)	CHI (VWL)	CHI (vwl/rur) HIPEC	Chi (nie)	Chi (VRP)
OR2	KNO	CHI (RUT)	Urologie (hbs)	RT	Urologie (MND)
OR3	KNO	Plas Chi	KNO	KNO	Plas Chi
OR4	CHI (COR)	Gyne	Chi Mamma	Plas Chi	Gyne
OR5	RT	CHI (SND/WOS)	RT (vwl/rur)	Urologie (pel/bex)	Urologie (P&B)
OR6	Urologie (P&B)	CHI (VWL)	Gyne	Chi (ODB)	Chi (Cor/rur)

Predicting the ward impact

- Depends on the Surgical Schedule
- Number of admission is uncertain
- Length or recovery is uncertain

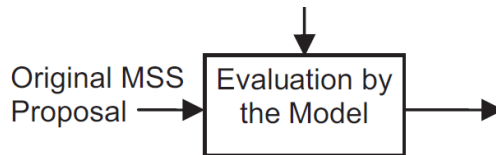


SOLUTION APPROACH



- Right people at the table
- Representative data
- Valid model for predicting the ward capacity

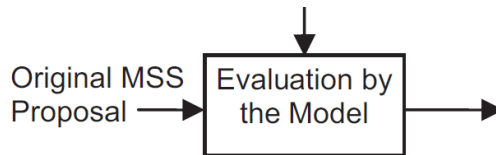
SOLUTION APPROACH



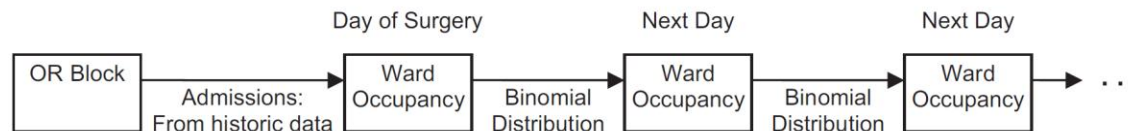
	Mon	Tue	Wed	Thu	
48 staffed beds	9.6%	21.8%	25.7%	63.3%	
49 staffed beds	5.7%	16.1%	19.6%	55.1%	
50 staffed beds	3.1%	11.2%	14.3%	46.6%	
51 staffed beds	1.5%	7.4%	9.8%	38.4%	
52 staffed beds	0.6%	4.5%	6.3%	31.1%	
53 staffed beds	0.2%	2.5%	3.8%	24.6%	
54 staffed beds	0.1%	1.2%	2.1%	19.0%	
55 staffed beds	0.0%	0.6%	1.1%	14.1%	
56 staffed beds	0.0%	0.2%	0.6%	10.1%	
57 staffed beds	0.0%	0.1%	0.2%	6.8%	
58 staffed beds	0.0%	0.0%	0.1%	4.2%	
59 staffed beds	0.0%	0.0%	0.0%	2.4%	

- Mean and median ward occupancies
- Probability of exceeding ward capacity
- Frequency of calling-in additional staff
- Fluctuations in ward occupancies

SOLUTION APPROACH



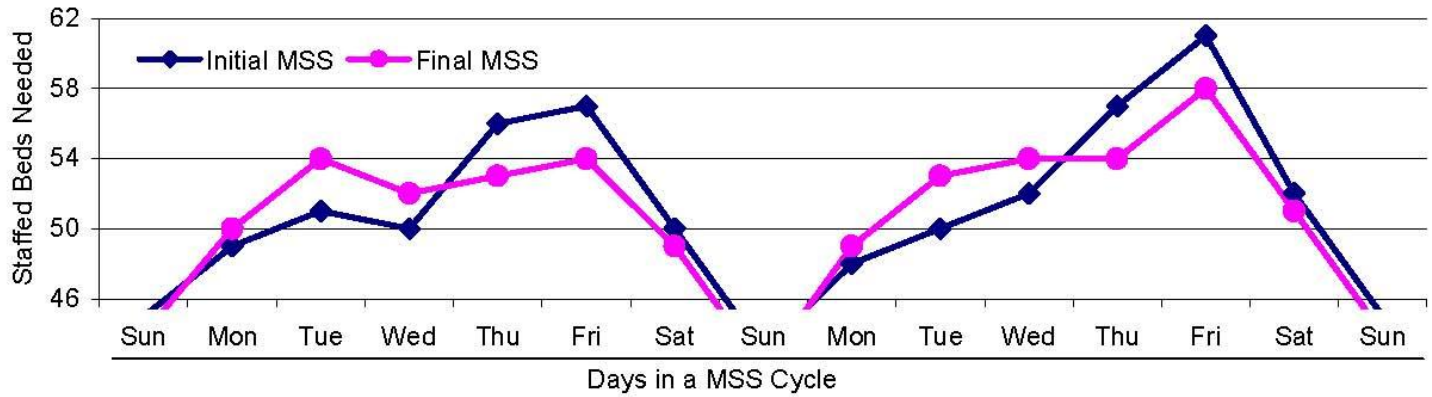
- Using historic data we know admission trends
- After admission a patient either stays or is discharged
 - i.e. each day can be modelled with a binomial distribution
- Since patients do not interfere with each other (i.e. they are independent) they can be “added” to compute the ward occupancy





RESULTS: NKI-AVL

- Peaks in ward occupancy are highly dependent on the surgical schedule
- Peaks are troublesome because
 - Difficult to staff
 - Increases risk of exceeding capacity
 - Causes hospital congestion





RESULTS: NKI-AVL

- A surgical schedule was designed through consensus building
- An additional OR was opened without expanding the wards
- Algorithm implemented in NKI-AVL business intelligence software

- Proof of concept
 - Designed and implemented a new MSS
 - Post implemented review of bed use further validated the model



RESULTS: OTHER HOSPITAL



LEIDEN UNIVERSITY MEDICAL CENTER



Academisch Medisch Centrum

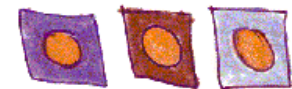


Isala klinieken



TECHNISCHE
UNIVERSITÄT
MÜNCHEN

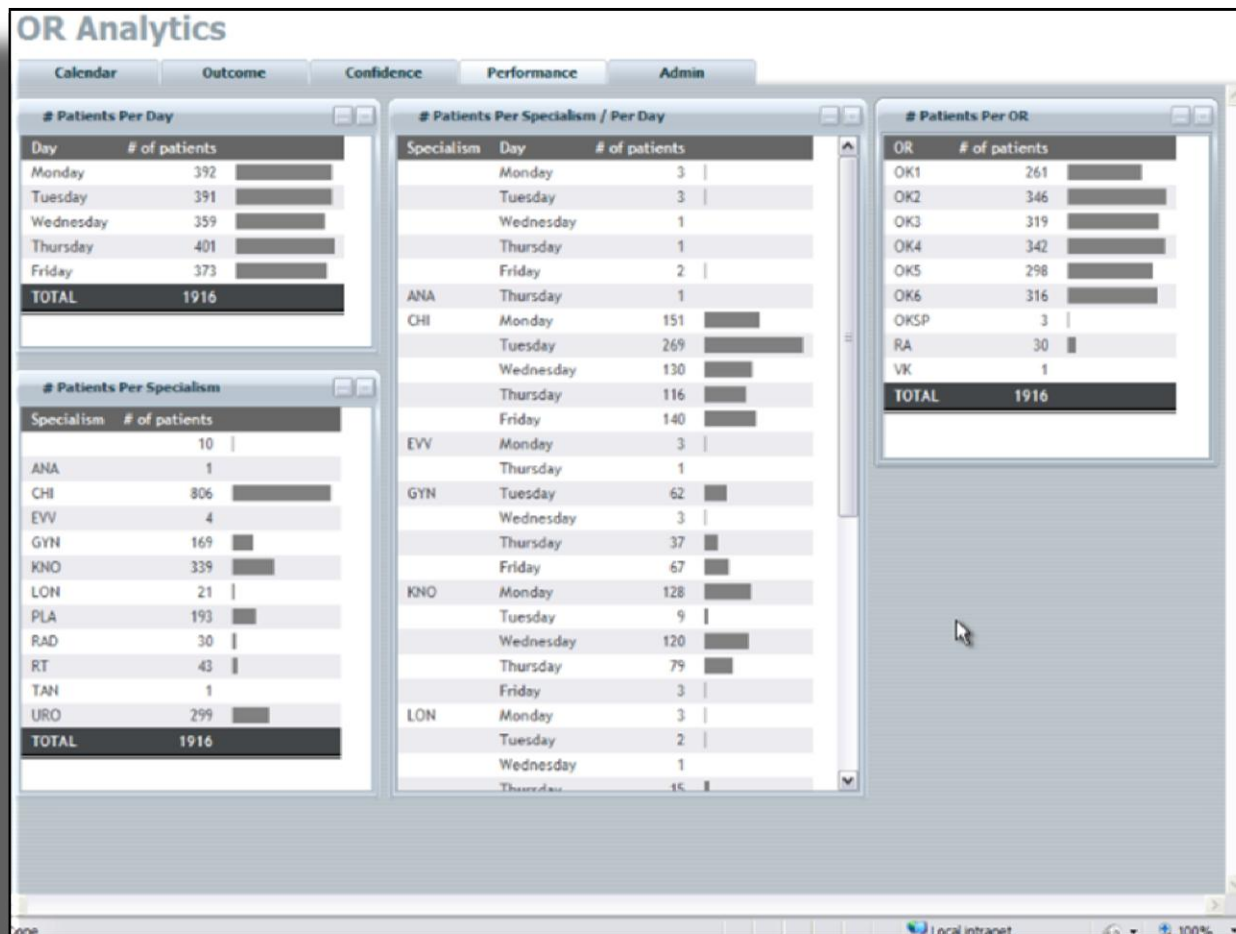
gelre ziekenhuizen



UNIVERSITY OF TWENTE.



RESULTS: COMMERCIALIZATION



RESULTS: ACADEMIC

Journal of the Operational Research Society (2011) 62, 1851–1860 © 2011 Operational Research Society Ltd. All rights reserved. 0167-6369/11 www.palgrave-journals.com/jors

An exact approach for relating recovering surgical patient workload to the master surgical schedule

P.T. Vanberkel^{1,2*}, R.J. Boucherie¹, E.W. Hans¹, J.L. Hurink¹, W.A.M. van Lent^{1,2} and W.H. van Harten^{1,2}
¹University of Twente, Enschede, the Netherlands; and ²Netherlands Cancer Institute-Antoni van Leeuwenhoek Hospital, the Netherlands

No other department influences the workload of a hospital more than the Department of Surgery and in particular, the activities in the operating room. These activities are governed by the master surgical schedule (MSS), which states which patient types receive surgery on which day. In this paper, we describe an analytical approach to project the workload for downstream departments based on this MSS. Specifically, the ward occupancy distributions, patient admission/discharge distributions and the distributions for ongoing interventions/treatments are computed. Recovering after surgery requires the support of multiple departments, such as nursing, physiotherapy, rehabilitation and long-term care. With our model, managers from these departments can determine their workload by aggregating tasks associated with recovering surgical patients. The model, which supported the development of a new MSS at the Netherlands Cancer Institute-Antoni van Leeuwenhoek Hospital, provides the decision support tool to relate downstream hospital departments to the operating room. *Journal of the Operational Research Society* (2011) 62, 1851–1860. doi:10.1057/jors.2010.107 Published online 6 October 2010

Keywords: probability; queuing; hospitals; surgical scheduling; ward occupancy

Introduction

Driven by an aging population, public opinion, increased health expenditures and long waiting lists, a flood of changes in the health-care system have been set into motion. Many of these changes aim to improve efficiency and are planned by considering patient interactions within a single department. By limiting the scope of projects to a single department, the complexity and uncertainty which is inherent in health care, becomes more manageable for the problem solver. However, suboptimal conditions may be drawn when only considering a single department, particularly if the influences of other services are ignored or if the impact of the change on the overall care chain is overlooked (Vanberkel *et al.*, 2010).

No other single hospital department influences the workload of other departments more than the Department of Surgery, and in particular, the activities in the operating room. This influence depends directly on what types of patients receive surgery and when. Generally speaking, more invasive surgeries require more care during a patient's recovery. Giving consideration to this downstream effect of the operating room is essential for balancing the workload

of the hospital. The first room time in Blake Carter, 1997; Blake Demonceaux, 2001; Wachet and Dexter, often described as a multiple stage process starts with the long-term to the surgical special surgery hours per year 1, is a strategic decision pattern and the patient. From this schedule (MSS) is developed which divides operating blocks) amongst the specific assignment of within the MSS is A fourth stage 'add the operating room at the day of surgery, development of a MSS. The MSS is of Demonceaux, 2001 dedicated to a surgical decision of which

*Correspondence: P.T. Vanberkel, University of Twente, Campus ES, Room E106, PO Box 217, Enschede, 7500 AB, the Netherlands.



Interacting Hospital Departments and Uncertain Patient Flows: Theoretical Models and Applications

Peter Tulkenes Vanberkel

Accounting for Inpatient Wards When Developing Master Surgical Schedules

Peter T. Vanberkel, MSc,*† Richard J. Boucherie, PhD,* Erwin W. Hans, PhD,† Johann L. Hurink, PhD,* Wineke A. M. van Lent, MSc,† and Wim H. van Harten, MD, PhD†

BACKGROUND: As the demand for health care services increases, the need to improve patient flow between departments has likewise increased. Understanding how the master surgical schedule (MSS) affects the inpatient wards and exploiting this relationship can lead to a decrease in surgery cancellations, a more balanced workload, and an improvement in resource utilization. We modeled this relationship and used the model to evaluate and select a new MSS for a hospital.

METHODS: An operational research model was used in combination with staff input to develop a new MSS. A series of MSSs were proposed by staff, evaluated by the model, and then scrutinized by staff. Through iterative modifications of the MSS proposals (i.e., the assigned operating time of specialties), insight is obtained into the number, type, and timing of ward admissions, and how these affect ward occupancy.

RESULTS: After evaluating and discussing a number of proposals, a new MSS was chosen that was acceptable to operating room staff and that balanced the ward occupancy. After implementing the new MSS, a review of the bed-use statistics showed it was achieving a balanced ward occupancy. The model described in this article gave the hospital the ability to quantify the concerns of multiple departments, thereby providing a platform from which a new MSS could be negotiated.

CONCLUSION: The model, used in combination with staff input, supported an otherwise subjective discussion with quantitative analysis. The work in this article, and in particular the

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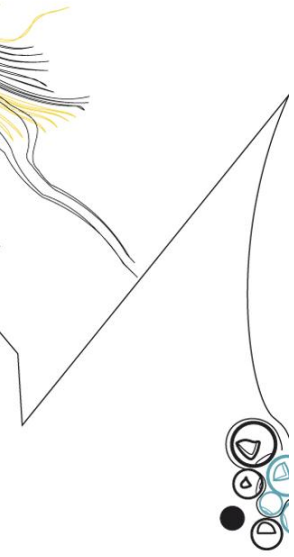
Springer



RESULTS: PARTNERSHIP

**Information
Builders**

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Questions?



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