



# UCL

# Clinical Operational Research Unit

Annual report

**2008**

# Contents

Introduction.....	3
The team.....	4
Example research projects in 2008.....	6
Publications in 2008.....	9
Forthcoming publications.....	14
Selected presentations in 2008.....	16
Working with the best: our collaborators.....	17
Our sources of funding.....	17

# Introduction

Welcome to the 2008 annual report of the Clinical Operational Research Unit (CORU) at University College London. We are a dedicated team of researchers that applies mathematical modelling and other operational research techniques to problems in healthcare. In keeping with the best traditions of operational research, we work in close collaboration with NHS staff, ensuring both that our work is informed by the experience and insight of those working on the front-line and that the problems we tackle are relevant.

In October we held a reception to celebrate the 25 year history of CORU at UCL. Guests heard the Medical Director of the NHS Professor Sir Bruce Keogh talk passionately about the drive for improving quality in the NHS. He emphasised the crucial role to be played by innovative methods for the interpretation of clinical outcome data such as those developed by CORU. Our most important contribution in this area has been the development of an audit method called VLAD, which is now used in cardiac surgery units throughout the UK and abroad. Indeed, 2008 saw the publication of a book entitled "VLAD for Dummies" produced by the Government of Queensland, Australia explaining the use of this method in their clinical improvement programme.

Although work related to clinical outcomes is an important part of our programme of research, it is by no means all that we do. Over our 25 year history, the unit has engaged in research concerning a wide range of clinical and organisational problems within the NHS. This diversity is evident in our 2008 publications in the medical and technical press. In addition to the evaluation of clinical outcomes, these publications address problems related to

patient safety, the health of women and children and NHS service delivery.

Our programme of work broadened in 2008 as we began a new collaboration with analysts and policy colleagues within the Department of Health to develop models that can be used to assist in enhancing the resilience of the NHS to a range of threats.

The diversity of our research means that there are many opportunities for cross-fertilisation between research in different clinical fields and areas of policy with, for instance, analytical methods developed to assist staffing decisions within a paediatric intensive care unit being adapted to predict the prevalence of cancer over the coming decades. The analytical approach that we employ in addressing problems, with the emphasis on simplicity and insight, is key to spotting and exploiting such opportunities.

A key feature of the unit's work has always been that, although primarily focused on producing practical solutions to real problems, we frequently develop new methods of analysis and new modelling paradigms, which are then adopted by others. Along with VLAD, examples include the development of probability models of the progression of patients' disease, similar to methods used widely in health economics, and more recent work on methods for capacity planning within healthcare.

I consider that, as a national resource, a unit such as CORU should serve as a centre of academic excellence in this way. It is this academic excellence and innovation that enables us to respond to and anticipate the research needs of government so successfully.

Martin Utley, Director

# The Team

## Dr Martin Utley

Director of the unit, Martin joined CORU in 1996 having gained a PhD in high-energy physics. Martin is actively involved in all of CORU's current research. His main interest lies in developing, adapting and applying operational research techniques to assist those planning, delivering or evaluating health services. Committed to this aim, Martin also acts as a scientific advisor to the National Confidential Enquiry into Patient Outcome and Death (NCEPOD).

## Professor Steve Gallivan

Steve has been active in operational research for over 25 years and served as Director of CORU between 1995 and 2007. Since April 2007, he has been devoting his time at CORU to a variety of ongoing projects. After gaining his PhD in pure mathematics, he started his OR career in traffic engineering and transport planning, before transferring his skills to the clinical sector. He has over 200 publications to his name, and is always looking for new ways of using mathematical methods in useful applications. Steve also acts as a scientific advisor to the NCEPOD.

## Professor Ray Jackson

Ray's long career bridges the worlds of academia, government and business. Having worked in OR for multi-national companies, the Department of Health, and the Universities of Southampton and Warwick, he became the founding Director of CORU in 1983. He retired in 1995, but maintains a consultant role within the unit.

## Professor Tom Treasure

Tom joined CORU following a long and successful career as a cardio-thoracic surgeon, during which he collaborated with CORU on research of mutual interest. In his honorary role, Tom contributes his considerable knowledge and clinical experience to ongoing projects concerning outcomes following surgery and hospital acquired infections, as well as conducting his own research concerning the evidence base for thoracic surgery.

## Dr Christos Vasilakis

Christos has an academic background in both operational research and computer science, and has more than ten years of experience as a researcher in health systems. After a number of years lecturing at another London university and having spent a year in Vancouver as a post-doctoral fellow, Christos joined CORU in 2007 as a Principal Research Fellow. He is currently working on projects related to emergency planning within the health service, hospital acquired infections and how best to involve clinicians in the development of simulation models.

## Dr Christina Pagel

Christina has a background in both mathematics and physics, gaining her PhD in space physics. After 3 years as a post-doctoral physicist in Boston, she decided to make the transition into operational research applied to health care and joined CORU in 2005. In 2008, Christina was promoted to the position of Senior Research Fellow. She is currently working on projects related to common mental health problems, congenital heart surgery and maternal mortality in the developing world.

### **Dr Francesca Fiorentino**

Francesca has a background in both physics and mathematics, gaining her PhD in mathematics applied to epidemiology in 2004. After working for The Environment Agency as a modelling officer, she joined CORU in 2007. Francesca is currently working on projects related to cancer prevalence, the display of clinical outcome data and thoracic surgery.

### **Mr Brian Reddy**

Having completed an undergraduate degree in Management Science and Information Systems Studies, Brian conducted research into the use of the Irish language in business before moving to London to obtain an MSc in Decision Sciences. Brian joined CORU in 2007 and is currently working on projects related to cardiac surgery.

### **Dr Andrew Skeen**

Andrew studied mathematics and statistics and finished his PhD in information theory in 2005. He worked for several years at the National Institute of Economic Social Research in London before joining CORU in 2008 to work on projects related to emergency planning within the health service and pharmacy safety.

### **Dr Sonya Crowe**

Sonya has a background in physics, gaining her PhD in experimental condensed matter physics in 2005. She subsequently joined the Government

Operational Research Service, working initially at the Export Credit Guarantee Department and then as a senior OR analyst at the Department of Health. Sonya has recently joined CORU to work on projects related to emergency planning within the health service and the monitoring of surgical wound infections.

### **Mrs Mary Gallivan**

Mary is a trained nurse who worked for several years as Assistant Director of Human Resources for Hammersmith Hospitals NHS Trust. Since retiring from the NHS, Mary has undertaken short term consultancy work on behalf of the unit in her role as an Honorary Research Fellow. Her in-depth knowledge of the NHS and of hospital management is invaluable to the unit.

### **Mr Chris Sherlaw-Johnson**

With an academic background in mathematics and operational research, Chris spent many years at CORU working on a variety of projects. Now leading a team within the monitoring and surveillance division of the Healthcare Commission, Chris retains active research links with CORU in areas of mutual interest and is an Honorary Senior Research Fellow within the unit.

### **Mrs Joanne English**

Joanne acts as both PA to the Director and as the unit administrator. She joined CORU in 2002.

#### **Contact details**

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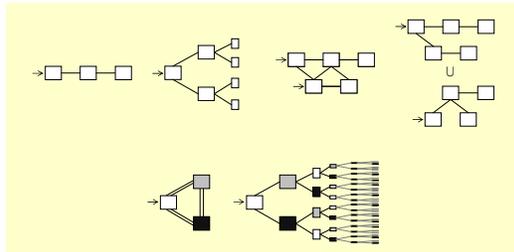
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CORU is hosted by the UCL Department of Mathematics within the UCL Faculty of Mathematical and Physical Sciences.

# Example research projects in 2008

CORU conducts research on a wide range of topics. Some of the research projects that the unit was engaged in during 2008 are described below.

## Mathematical modelling to assist the restructuring of primary mental health care services



Along with academic partners from the University of York and The University of Manchester, we have been working with four primary mental health care trusts to develop tools to assist with the reconfiguration of services for people with anxiety and depression.

Novel mathematical models of the flow of people through systems composed of different clinical processes have been used as the basis of a software tool. This software will be evaluated at ten sites nationally in 2009 with the expectation that it will be made available to services across the UK.

See publications 2 & 42.

## Pharmacy Safety

A considerable amount of research attests to the fact that errors in the administration of drug therapy are frequent. Such errors include delays in the administration of medications within hospital, administration of the incorrect dose or of the wrong drug, or omission of scheduled administrations, either through errors within the health care system or through forgetfulness on the part of the patient. Although the level of

such errors is frequently measured, the potential harm to patients has not been well quantified.

Working with world-renowned researchers in this field from the London School of Pharmacy, we are developing mathematical models that link standard pharmacokinetic models with stochastic analysis and models of patient behaviour. The aims of our work are to quantify the potential harm associated with non-adherence to medication and to generate insights into the complex relationship between health care systems, biological systems and patient behaviour that can be used to reduce or to ameliorate the harmful effects of non-adherence to medication.

See publications 1, 6, 7 & 44.

## Trends in cancer prevalence

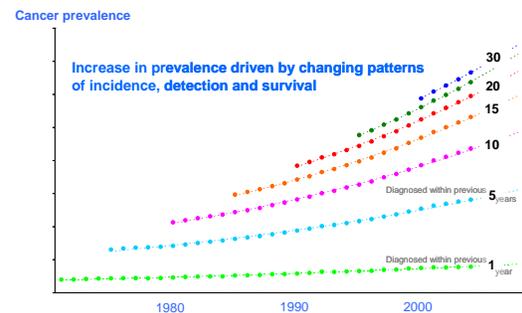


image courtesy of Kings College London

For a number of reasons, the prevalence of cancer is increasing among the UK population. An important component of the Cancer Reform Strategy is to assess and address the needs of people living with a diagnosis of cancer.

CORU is working with colleagues at the Thames Cancer Registry and Macmillan Cancer Support to build mathematical models to make predictions concerning cancer prevalence over the coming decades. Ultimately, our aim is to

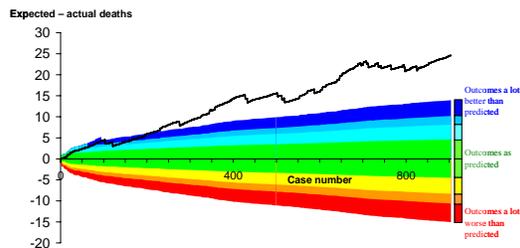
provide estimates as to the number of people at each of a number of stages of their disease or recovery with a view to informing the provision of health and other services for this growing section of the population.

### Assisting the work of NCEPOD

Members of CORU act as Scientific Advisors to the National Confidential Enquiry into Patient Outcome and Death (NCEPOD), an organisation dedicated to improving clinical outcomes through the production of research reports. These reports are based on confidential summaries of cases provided by practicing surgeons, anaesthetists and physicians. We assist NCEPOD in the design of studies and in the analysis and reporting of data. Additionally, the voting system used by the steering group of NCEPOD to select topics for study was devised by CORU.

See publications 5 & 37.

### Risk-modelling in congenital heart surgery



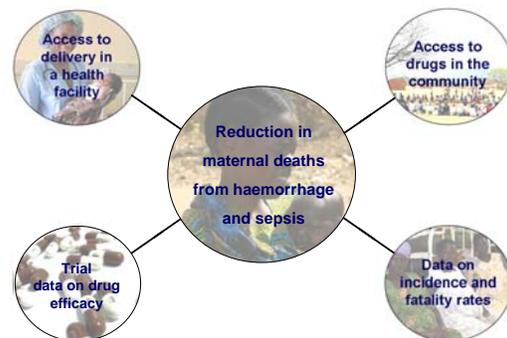
Audit and clinical governance in adult cardiac surgery have benefited greatly from the existence of a widely accepted model for the risk of peri-operative death and tools developed within CORU for monitoring risk-adjusted outcomes.

No widely accepted risk model exists for use in congenital heart surgery, partly due to the great diversity in diagnoses, co-morbidities and surgical procedures concerned. CORU is working with congenital heart surgeons at Great Ormond Street Hospital for Children to

assess a locally developed risk model and to establish whether the routine adjustment of surgical outcomes for case mix is feasible. We are collaborating with the Central Cardiac Audit Database such that UK-wide data can be used to ensure that any tools developed have applicability across different surgical units.

See publications 40 & 41.

### Exploring strategies for reducing maternal mortality in the developing world



In sub-Saharan Africa, little progress had been made in meeting the Millennium Development Goal to reduce the rate of maternal mortality. CORU is working with colleagues at the UCL Institute of Child Health and clinicians in Malawi to develop mathematical models that can be used to explore the impact of different strategies for reducing the risk of death to women during and immediately after childbirth. An important feature of this work is that the potential impact of different strategies can be explored among different social and economic sub-groups of a population.

Our initial work has focussed on estimating the effect on maternal deaths, across economic groups, of improving access to uterotonic and antibiotic drugs in Malawi through health workers or women volunteers at community level.

## The surgical removal of pulmonary metastases in colorectal cancer patients

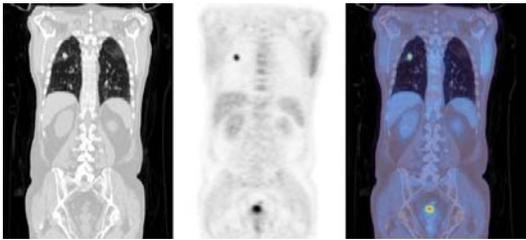


image courtesy of Dr Sally Barrington

The surgical removal of pulmonary metastases in patients with colorectal cancer has become common practice. We are engaged in a programme of research to challenge the evidence cited in support of this practice and to provide better evidence as to whether surgery confers benefit that outweighs the harmful effects of the operation.

Use of a simple mathematical model has established that the survival rates reported in surgical case series are not sufficient evidence for the continuation of this surgery. Plans for a randomised controlled trial in this area are well advanced.

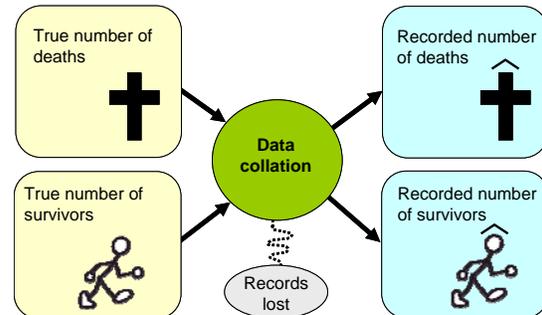
See publications 13, 18, 30, 32 & 46.

## The monitoring and reporting of surgical wound infections

Hospital acquired infections such as MRSA are a major concern for clinicians and for the public. As part of our work in the area of improving patient safety, we are developing practical tools to assist with the monitoring and reporting of surgical wound infections. Software has been developed to standardise and automate the reporting of the occurrence of surgical wound infections to clinical teams. By alerting clinicians to potential problems, the hope is that this work will result in a reduction in the number of surgical wound infections and, consequently, save many lives and reduce post-operative morbidity. The next step in our work will be to evaluate the impact of an early-warning

system designed to identify, in a timely fashion, trends in infection rates that warrant further investigation.

## Modelling the impact of errors in databases on clinical governance



For many good reasons, the quantitative analysis and reporting of clinical outcomes is viewed as an increasingly important activity within the UK health care system. Given that it is widely accepted that large clinical databases will, almost inevitably, contain errors, CORU is conducting research into how this fact is likely to affect the validity of conclusions drawn from analyses of these data. Mathematical modelling techniques have been used to establish that relatively modest levels of erroneous data can lead to grossly inaccurate estimates of mortality rates, particularly for clinical interventions associated with low mortality rates. This work is being conducted in collaboration with surgeons from Great Ormond Street Hospital for Children and the Hospital for Sick Children in Toronto, Canada.

See publications 4, 25 & 35.

## Other work

In 2008 we also conducted work in relation to radical surgery for pleural mesothelioma, the engagement of clinicians in simulation studies, workforce planning in a cardiac intensive care unit, an external support for the Marfan aorta and the resilience of the NHS to a range of threats.

# Publications in 2008

Copies of all publications are available on request.

1. Gallivan S, Taxis K, Dean Franklin B, Barber N. (2008) Is the principle of a stable Heinrich ratio a myth? : a multimethod analysis. *Drug Safety*. 31(8): 637-642
2. Utley M, Gallivan S, Pagel C, Richards D (2008) Analytical methods for calculating the distribution of the occupancy of each state within a multi-state flow system. *IMA Journal of Management Mathematics*. doi:10.1093/imaman/dpn031
3. Sherlaw-Johnson C, Datta P, McCarthy M (2008) Hospital differences in patient satisfaction with care for breast, colorectal, lung and prostate cancers. *European Journal of Cancer*. 44(11):1559-65
4. Gallivan S, Stark J, Pagel C, Williams G, Williams WG (2008) Dead reckoning: can we trust estimates of mortality rates in clinical databases? *European Journal of Cardio-thoracic Surgery*. 33: 334-340
5. Cooper H, Findlay G, Martin IC, Mason DG, Mason M, Utley M (2008) Death following a first time, isolated coronary artery bypass graft: The heart of the matter. *National Confidential Enquiry into Patient Outcome and Death*
6. Gallivan S, Pagel C, Utley M, Dean Franklin B, Taxis K, Barber N. (2008) A technical note concerning non-adherence to drug therapy: exact expressions for the mean and variance of drug concentration. *Health Care Management Science*. 11(3): 296-301
7. Smith D, Pagel C, Utley M, Gallivan S. (2008) Quantifying the impact of non-adherence to drug therapy: a technical note concerning an application of a branch and bound algorithm. *Health Care Management Science*. 11(3): 302-305
8. Vasilakis C, Lecznarowicz D (2008) Application of Unified Modelling Language (UML) to the modelling of health care systems: an introduction and literature

- survey. *International Journal of Healthcare Information Systems and Informatics*. 3:39-52.
9. Ferko N, Postma M, Gallivan S, Kruzikas D, Drummond M (2008) Evolution of the health economics of cervical cancer vaccination. *Vaccine*. 26 Suppl 5:F3-15.
  10. Utley M, Jit M, Gallivan S. (2008) Restructuring routine elective services to reduce overall capacity requirements within a local health economy. *Health Care Management Science*. 11(3): 240-247
  11. Debicki D, Ferko N, Demarteau N, Gallivan S, Bauch C, Anonychuk A, Mantovani L, Capri S, Chou CY, Standaert B, Annemans L (2008) Comparison of detailed and succinct cohort modelling approaches in a multi-regional evaluation of cervical cancer vaccination. *Vaccine*. 26 Suppl 5:F16-28.
  12. Vasilakis C, Lecznarowicz D, Lee C. (2008) Modelling health systems: delivery of care to older patients with hip fracture. In: *Lansley P, Chappell L. eds., SPARC Executive Summaries*. Available from [www.sparc.ac.uk](http://www.sparc.ac.uk)
  13. Treasure T, Internullo E, Utley M. (2008) Resection of pulmonary metastases: a growth industry. *Cancer Imaging*. 8: 121-124
  14. Gallivan S (2008) Challenging the role of calibration, validation and sensitivity analysis in relation to models of health care processes. *Health Care Management Science*. 11: 208-213
  15. Utley M, Treasure T (2008) The use of scoring systems in selecting patients for lung resection: work-up bias comes full circle. *Thoracic Surgery Clinics*. 18 pp:107-112
  16. Chong LY, Treasure T (2008) Acupuncture to relieve the pain of thoracotomy: Commentary on randomized, controlled trial. *Journal of Thoracic and Cardiovascular Surgery*. 136(6):1470-1

17. Treasure T (2008) Are randomised trials needed in the era of rapidly evolving technologies? *European Journal of Cardiothoracic Surgery*.  
doi:10.1016/j.ejcts.2008.08.032
18. Internullo E, Cassivi SD, Van Raemdonck D, Friedel G, Treasure T (2008) Pulmonary metastasectomy: a survey of current practice amongst members of the European Society of Thoracic Surgeons. *Journal of Thoracic Oncology*. 3(11):1257-66.
19. Abbi R, El-Darzi E, Vasilakis C (2008) Analysis of stopping criteria for the EM algorithm in the context of patient grouping according to length of stay. *Proceedings of the 4th IEEE Conference on Intelligent Systems*. vol 1, pp. 3-9 – 3-14. DOI: 10.1109/IS.2008.4670413
20. Abbi R, El-Darzi E, Vasilakis C and Millard PH. (2008) A Gaussian mixture model approach to grouping patients according to their hospital length of stay. In *21st IEEE International Symposium on Computer-based Medical Systems (CBMS'08)*, Finland, IEEE Press, 524-529. DOI: 10.1109/CBMS.2008.69
21. Bate P, Robert G, Gabbay J, Gallivan S, Jit M, Utley M, Le May A, Pope C, Croft White C. (2008) The development and implementation of NHS Treatment Centres as an organisational innovation. National Institute for Health Research Service Delivery Organisation Programme. 1-6  
[www.sdo.lshtm.ac.uk/files/adhoc/45-research-summary.pdf](http://www.sdo.lshtm.ac.uk/files/adhoc/45-research-summary.pdf)
22. McCarthy M, Gonzalez-Isquierdo A, Sherlaw-Johnson C, Khachatryan A, Coleman M P, Racht B. (2008) Comparative indicators for cancer network management in England: availability characteristics and presentation. *BMC Health Services Research*. 8: 45
23. Abbi R, El-Darzi E, Vasilakis C and Millard PH (2008). Length of stay based grouping and classification methodology for modelling patient flow. *Journal of Operations and Logistics*. 2:1-9.

24. McCarthy M, Datta P, Sherlaw-Johnson C, Coleman M, Ratchet B (2008) Is the performance of cancer services influenced more by hospital factors or by specialization? *Journal of Public Health*. 30(1): 69-74
25. Gallivan S, Pagel C. (2008) Modelling of errors in databases. *Health Care Management Science*. 11(1): 35-40
26. Baker R D, Chausalet T J, Utlely M (2008) Editorial: IMA Health 2007. *Health Care Management Science*. 11: 87-88
27. †Crooker NU, Pagel C. (2008) Residual strahls in solar-wind electron dropouts: Signatures of magnetic connection to the Sun, disconnection, or interchange reconnection? *Journal of Geophysical Research*. 113: A02106
28. Lui P, El-Darzi E, Lei L, Vasilakis C, Chountas P, Huang W (2008) Applying data mining algorithms to inpatient dataset with missing values. *Journal of Enterprise Information Management*. 21(1): 81-92
29. Sobolev B, Harel D, Vasilakis C, Levy A. (2008) Using the Statecharts paradigm for simulation of patient flow in surgical care. *Health Care Management Science*. 11: 79-86
30. Treasure T. (2008) Pulmonary metastasectomy for colorectal cancer: weak evidence and no randomised trials. *European Journal of Cardio-Thoracic Surgery*. 33: 300-302
31. Pagel C, Utlely M, Gallivan S (2008) The dynamic forecasting of short to medium term workload based on current case mix. In Eds Xie X, Lorca F, Marcon E, *Operations Research for Health Care Delivery Engineering, Proceedings of the 33<sup>rd</sup> meeting of the European working group on Operational Research Applied to Health Services, St Etienne, July 2007*. ISBN:978-2-86272-507-9 pp:265-272.

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† This work was not supported from CORU funds.

32. Utley M, Treasure T, Linklater K, Møller H (2008) Better out than in? The resection of pulmonary metastases from colorectal tumours. *In Eds Xie X, Lorca F, Marcon E, Operations Research for Health Care Delivery Engineering, Proceedings of the 33<sup>rd</sup> meeting of the European working group on Operational Research Applied to Health Services, St Etienne, July 2007.* ISBN:978-2-86272-507-9 pp:493-500.
33. Treasure T, Utley M, Berrisford R (2008) A risk model for lung resection: data from the European Thoracic Database Project. *European Journal of Anaesthesiology.* 8;30:1-7.
34. McCarthy M, Datta P, Sherlaw-Johnson C (2008) Organizational determinants of patients' experiences of care for breast, lung and colorectal cancers. *European Journal of Cancer Care.* doi:10.1111/j.1365-2354.2008.00966.x
35. Pagel C, Gallivan S (2008) Exploring potential consequences on mortality estimates of errors in clinical databases. *IMA Journal of Management Mathematics.* doi:10.1093/imaman/dpn034
36. Vasilakis C, El-Darzi E, Chountas P (2008) A decision support system for measuring and modelling the multi-phase nature of patient flow in hospitals. *In: Intelligent techniques and tools for novel system architectures, In: Studies in Computational Intelligence, eds. Chountas P, Petrounias I; Kacprzyk J., Springer* 109, 201-217.

Members of CORU also contributed to the following report produced in 2008 by the National Confidential Enquiry into Patient Outcome and Death:

37. For better, for worse? A review of the care of patients who died within 30 days of receiving systemic anti-cancer therapy. NCEPOD. ISBN 978-0-9560882-0-8.

## Forthcoming publications

38. Gallivan S, Pagel C, Utley M (forthcoming) Simple sums and useful products - in praise of minimalism. *Proceedings of the 34th annual conference of the European Working Group on Operational Research Applied to Health Services.*
39. Utley M, Chausalet T, Baker R (forthcoming) Applying mathematics to problems in healthcare; a call to pencils. *IMA Journal of Management Mathematics.*
40. Tsang VT, Brown KL, Johanssen Synnergren M, Kang N, de Leval MR, Gallivan S, Utley M (forthcoming) Monitoring risk adjusted outcomes in congenital heart surgery: does the appropriateness of a risk model change with time? *Annals of Thoracic Surgery.*
41. Tsang VT, de Leval MR, Utley M (forthcoming) Paediatric cardiac surgery, centre size, and outcomes. *Scandinavian Journal of Cardiovascular Surgery.*
42. Gallivan S, Utley M, Pagel C, Richards D (forthcoming) Applying operational research techniques to the reorganisation of mental health care in the UK. *Proceedings of the 32<sup>nd</sup> Annual Conference of the European Working Group on Operational Research Applied to Health Services*
43. Utley M, Gallivan S, Jit M (forthcoming) Application of a simple analytical model of capacity requirements. *Proceedings of the 32<sup>nd</sup> Annual Conference of the European Working Group on Operational Research Applied to Health Services.*
44. Pagel C, Smith D, Gallivan S, Utley M (forthcoming) Application of a branch and bound algorithm to a stochastic pharmacokinetic model. *Proceedings of the 32<sup>nd</sup> Annual Conference of the European Working Group on Operational Research Applied to Health Services*
45. Gallivan S (forthcoming) Applying mathematical methods to problems associated with health care. *Proceedings of the 32<sup>nd</sup> Annual Conference of the European Working Group on Operational Research Applied to Health Services*

46. Treasure T, Fallowfield L, Farewell V, Ferry D, Lees B, Leonard P, Macbeth F, Utley M (forthcoming) Pulmonary metastasectomy in colorectal cancer: Time for a trial. *European Journal of Surgical Oncology*.
47. El-Darzi E, Abbi R, Vasilakis C, Gorunescu F, Gorunescu M & Millard P.H. (forthcoming) Length of stay-based clustering methods for patient grouping. *In: Intelligent Patient Management, eds. McClean S.I, Millard P.H, El-Darzi E & Nugent C, Springer.*

# Selected presentations 2008

1. Simple sums and useful products – in praise of minimalism , ORAHS 2008, Toronto, Canada, 28 July – 1 August 2008.
2. Monitoring surgical wound infection rates: adjusting for speciality average vs. individual patient risk, ORAHS 2008, Toronto, Canada, 28 July – 1 August 2008.
3. Working above capacity: modelling a generic mental health care service, ORAHS 2008, Toronto, Canada, 28 July – 1 August 2008.
4. Cross-fertilisation between road traffic theory and health OR, OR 50, York, 9 – 11 September 2008.
5. Different problem same solution, OR50, York, 9 – 11 September 2008.
6. Estimating the survival benefit associated with radical surgery, International Mesothelioma Interest Group Congress, Amsterdam, The Netherlands, 25-27 September 2008.
7. The princess who wanted the moon: lessons for interdisciplinary research, Modelling and Simulation in Healthcare Network (MASHnet) conference, London, 23 April 2008.
8. Pulmonary metastasectomy for colorectal cancer: How do we square evidence and practice? European Association for Cardiothoracic Surgery, Lisbon, Portugal, 13 – 17 September 2008.
9. The role of simulation and other modelling approaches in health care, Marie Curie network on Monte Carlo simulation, Debrecen, Hungary, 8 - 16 August 2008.

# Working with the best: our collaborators

The contributions of our clinical collaborators and academic partners are essential to CORU's research. In 2008 we benefited in particular from collaborations with

Professor Nick Barber	London School of Pharmacy
Dr Sally Barrington	The Clinical PET centre, St Thomas' Hospital
Professor Bryony Dean Franklin	Hammersmith Hospitals NHS Trust
Professor Henrik Møller	Kings College London
Dr Mike O'Doherty	The Clinical PET centre, St Thomas' Hospital
Professor Dave Richards	The University of Exeter
Mr Jaroslav Stark	Great Ormond Street Hospital for Children
Mr Victor Tsang	Great Ormond Street Hospital for Children
Professor Bill Williams	The Hospital for Sick Children, Toronto
Dr Peter Wilson	University College London Hospital
Dr Katja Taxis	University of Groningen
The Thoracic Unit	Guy's Hospital
Professor Anthony Costello	UCL Institute of Child Health
Dr Kate Brown	Great Ormond Street Hospital for Children
Dr Alain Vuylsteke	Papworth Hospital
Professor Lesley Fallowfield	University of Sussex
Professor Vern Farewell	MRC Biostatistics Unit
Mr Ian Hunt	University of Alberta

## Our sources of funding

CORU receives core funding from the Department of Health Policy Research Programme. Other bodies which funded CORU research in 2008 include the National Institute of Health Research (NIHR) Service Delivery and Organisation, the Engineering and Physical Sciences Research Council, Macmillan Cancer Support, the UCL Institute of Child Health and the UCL Faculty of Mathematical and Physical Sciences.