UCL

Clinical Operational Research Unit

Annual report

2009

Contents

Introduction

Welcome to the 2009 annual report of the Clinical Operational Research Unit (CORU) at University College London. For those unfamiliar with the unit, CORU is a team of researchers dedicated to applying 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. This ensures 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.

Within the clinical community, the unit is perhaps best known for its expertise in the analysis, presentation and interpretation of clinical outcome data. However, as can be seen from the following sections, CORU's work this past year has ranged from assisting workforce planning in a cardiac intensive care unit through to evaluating ways of making progress on the Millenium Development Goals on maternal and neonatal mortality. As ever, we have been highly successful in disseminating our work through both the medical and technical press. In addition to journal articles, our work is disseminated through the distribution of software applications and analytical tools.

2009 saw recognition of the immense contribution made by CORU's Steve Gallivan to operational research applied to health when the Canadian OR Society awarded him the prestigious Harold Lardner prize. In his address at their conference in Toronto, Steve discussed several of the people that have influenced his career including CORU founder Ray Jackson, who pioneered Markov modelling in health, and Tom Treasure. It was with Tom that CORU developed graphical methods for monitoring risk-adjusted outcomes that are now used the world over.

In addition to practical advances such as this, CORU has a history of using mathematical modelling to provide useful insights concerning challenging problems. One example this year was our timely work related to triage to critical care in the context of a pandemic. The simple analytical models we developed informed debate on this complex and emotive issue as the H1N1 pandemic unfolded.

In addition to informing clinical practice and contingency planning, OR will play an important role in helping health care providers and commissioners to minimise the impact of the economic downturn. OR can help identify cost-neutral improvements to care and "care-neutral" efficiencies. It can be used to explore trade-offs between different aspects of service delivery and help organisations make more effective use of information when planning or evaluating services. For these reasons, operational researchers are perhaps a more valuable resource now than they have ever been.

Martin Utley, Director

The Team

Professor 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 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 30 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 research 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 NCEPOD.

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 regarding 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 child health in low income countries.

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 and the evidence base for 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 risk scoring within paediatric congenital heart surgery.

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 joined CORU in 2009 and is working on projects related to emergency planning within the health service, the monitoring of surgical wound infections and the use of bridging technologies within child heart transplant programmes.

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 surveillance division of the Care Quality Commission, Chris retains active research links with CORU in areas of mutual interest and is an Honorary Senior Research Fellow within the unit.

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.

Mrs Joanne English

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

During 2009, CORU also benefited from the services of **Dr Andrew Skeen.**

Contact details

Clinical Operational Research Unit
4 Taviton Street
London
WC1H 0BT

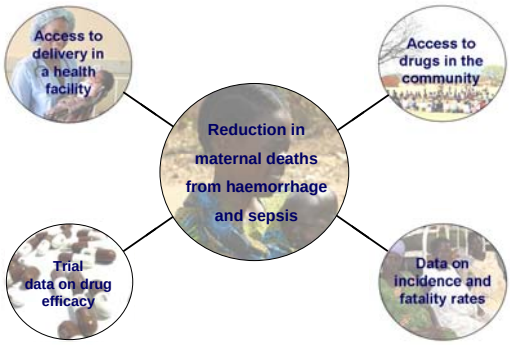
Telephone: +44(0)20 7679 4509
Fax: +44(0)20 7813 2814
Email: m.utley@ucl.ac.uk
j.english@ucl.ac.uk

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

Example research projects in 2009

CORU conducts research on a wide range of topics. Some of the research projects that the unit was engaged in during 2009 are described below.

Exploring strategies for reducing maternal and neonatal mortality in low income countries



In sub-Saharan Africa, little progress had been made in meeting the Millennium Development Goal to reduce the rate of maternal mortality. CORU worked with colleagues at the UCL Institute of Child Health and clinicians in Malawi to develop a mathematical model that can be used to explore the impact of different strategies for reducing the risk of death to women 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. This work is informing a planned, large-scale evaluation in sub-Saharan Africa.

We have also assisted in the analysis of cluster-randomised trials on the effect of community women's groups on neonatal deaths in South Asia.

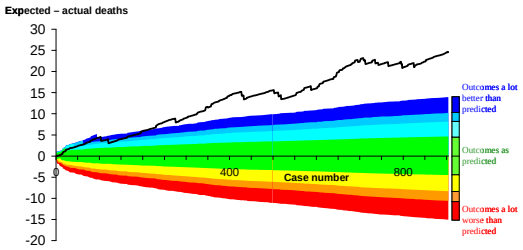
See publications **2**, **37**, **39**, **40**, **44**

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 research towards improving patient safety, we have developed practical tools to assist with the monitoring and reporting of surgical wound infections, working with clinicians at University College London Hospital. Software has been developed to standardise and automate the reporting of surgical wound infections to clinical teams; this is now in use.

See publication **20**

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 and the Central Cardiac Audit Database to establish whether the routine adjustment of surgical outcomes for case mix is feasible.

See publications **4**, **23**, **24**

Trends in cancer prevalence

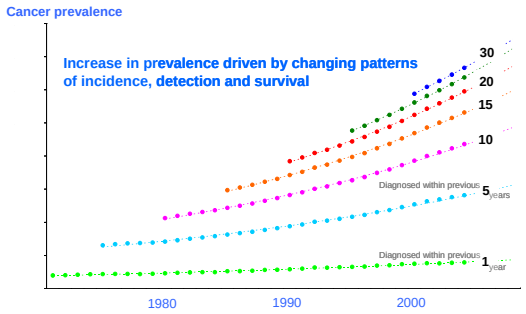


image courtesy of Kings College London

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 for predicting 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 care and other services for this growing section of the population.

See publication **13**

The surgical removal of pulmonary metastases in colorectal cancer patients

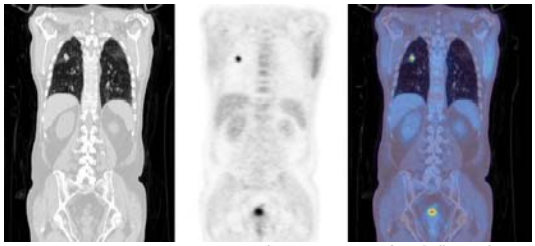


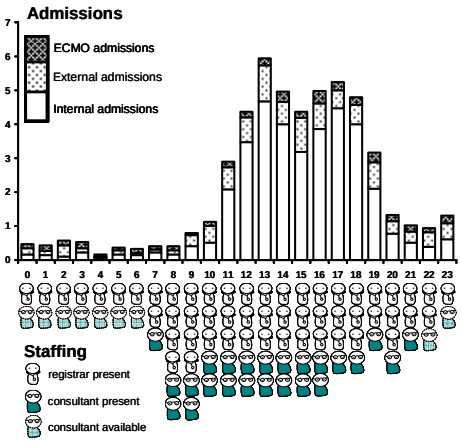
image courtesy of Dr Sally Barrington

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. A randomised controlled trial has been launched.

See publications **9**, **38**, **42**, **43**

Workforce planning in a cardiac intensive care unit



In a short exercise working with consultant intensivists, we compared patterns of admission to cardiac intensive care to staffing levels by time of day and day of week. This work informed decisions regarding future staffing of the unit concerned.

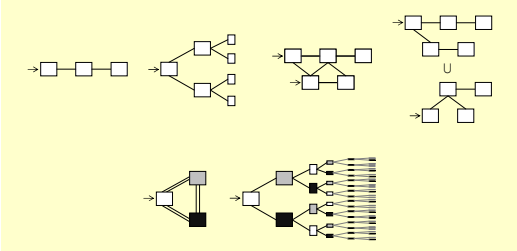
Triage in the context of pandemic influenza

Working with consultant intensivists from Great Ormond Street Hospital, we developed simple analytical models to inform thinking concerning processes of triage to determine access to critical care during a pandemic. Our work focussed attention on the need to be clear as to the objectives of triage and explored the nature and scale of differences that would have to exist between different patient groups for triage to have the intended benefits.

Mathematical analysis to inform decisions concerning heart transplantation

It is possible to prolong the life of some children awaiting heart transplantation using “bridging” technologies. We are working with surgeons, cardiologists and intensivists at Great Ormond Street Hospital to address a number of questions raised by the availability of this expensive resource. Bridging may increase the chance of an individual patient receiving a transplant and of a donated organ being used. However, these benefits need to be considered alongside the opportunity costs associated with the prolonged use of intensive care beds and the fact that for some patients this burdensome intervention will prove unavailing.

Modelling to assist the restructuring of primary mental health care services

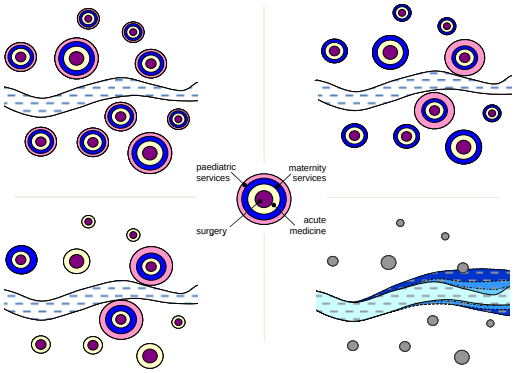


Along with academic partners from the University of Exeter and The University of Manchester, we have been working with four primary mental health care trusts to develop tools to assist with the reconfiguration of services for people with anxiety and depression.

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 was evaluated at sites nationally in 2009 and will be made available to services across the UK.

See publications **5**, **17**, **32**

Developing a tool to assess the resilience of a local health economy



CORU is working with colleagues within the Health Protection Analytical Team and the Emergency Preparedness division at the Department of Health to establish the feasibility of developing a tool for assessing the resilience of local health economies to a range of threats, including flooding.

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 **10**, **26**, **27**

Other work

In 2009 we also worked on the engagement of clinicians in simulation studies, an external support to the Marfan aorta and simulation modelling to improve the efficient operation of a hospital pharmacy.

Publications in 2009

Copies of all publications are available on request.

1. Treasure T, Waller D, Tan C, Entwisle J, O'Brien M, O'Byrne K, Thomas G, Snee M, Spicer J, Landau D, Lang-Lazdunski L, Bliss J, Peckitt C, Rogers S, Marriage E, Coombes G, Webster-Smith M, Peto J (2009) The mesothelioma and radical surgery randomized control trial: The MARS feasibility study, *Journal of Thoracic Oncology,* **4(10):** 1254-1258

2. Pagel C, Lewycka S, Colbourn T, Mwansambo C, Meguid T, Chiudzu G, Utley M, Costello AML, (2009) Estimation of potential effects of improved community-based drug provision, to augment health-facility strengthening, on maternal mortality due to post-partum haemorrhage and sepsis in sub-Saharan Africa: an equity effectiveness model, *The Lancet,* **374(9699):** 1441-1448

3. Vasilakis C, Lecznarowicz D, Lee C (2009) Developing model requirements for patitent flow simulation studies using the Unified Modelling Language (UML), *Journal of Simulation,* **3:** 141-149

4. Treasure T, Bridgewater B, Gallivan S (2009) Quality assessment of cardiac surgery in Britain, *Deutsche Medizinische Wochenschrift,* **134(S6):** S237-S23

5. Utley M, Gallivan S, Pagel C, Richards D. (2009) Analytical methods for calculating the distribution of the occupancy of each state within a multi-state flow system, *IMA Journal of Management Mathematics,* **20(4)**: 345-355

6. Pagel C, Gallivan S. (2009) Exploring potential consequences on mortality estimates of errors in clinical databases, *IMA Journal of Management Mathematics,* **20(4):** 385-393

7. Utley M, Chaussalet, Baker,R. (2009) Applying mathematics to problems in health care: a call to pencils, *IMA Journal of Management Mathematics,* **20(4):** 323-325

8. Treasure T, Gallivan S, Golesworthy T, Thornton W, Lamperth M, Mohiaddin R, Pepper J, Anderson R H (2009) Unknown Unknowns: The aorta through the looking glass, *European Journal Cardio-thoracic of Surgery* **35(6):** 925-6

9. Treasure T, Fallowfield L, Farewell V, Ferry D, Lees B, Leonard P, Macbeth F, Utley M (2009) Pulmonary metastasectomy in colorectal cancer: Time for a trial *European Journal of Surgery Oncology* **35(7):** 686-689

10. Smith N, Weyman D, Findlay, G, Martin I, Carter S, Utley M, Treasure T (2009) The management of trauma victims in England and Wales: a study by the National Confidential Enquiry into Patient Outcome and Death, *European Journal of Cardio-thoracic Surgery* **36(2):** 340-3

11. Tsang V, Utley M (2009) Invited commentary on the paper by Giamberti et al, *Annals of Thoracic Surgery* **88(4)**:1289-90

12. Sobolev B G, Sanchez V, Vasilakis C (2009) Systematic review of the use of computer simulation modelling of patient flow in surgical care, *Journal of Medical Systems* doi:10.1007/s10916-009-9336-z

13. Maddams J, Brewster D, Gavin A, Steward J, Elliott J, Utley M, Møller H (2009) Cancer prevalence in the United Kingdom: estimates for 2008, *British Journal of Cancer* **101(3)**:541-7

14. Costello A, Abbas M, Allen A, Ball S, Bell S, Bellamy R, Friel S, Groce N, Johnson A, Kett M, Lee M, Levy C, Maslin M, McCoy D, McGuire B, Montgomery H, Napier D, Pagel C, Patel J, de Oliveira J A P, Redclift N, Rees H, Rogger D, Scott J, Stephenson J, Twigg J, Woolf J, Patterson C. (2009) Managing the health effects of climate change, *The Lancet* **373:** 1693-1733

15. Pagel C, Smith D, Gallivan S, Utley M (2009) Application of a branch and bound algorithm to a stochastic pharamacokinetic model, *In: Lubicz,M*. ed., *Operational*

Research Applied to Health Services in Action; pp:255-262, ISBN: 978-83-7493-409-1

16. Utley M, Gallivan S, M Jit (2009) Application of a simple analytical model of capacity requirements, *In: Lubicz,M*. ed., *Operational Research Applied to Health Services in Action*; pp:243-253, ISBN: 978-83-7493-409-1

17. Gallivan S, Utley M, Pagel C, Richards D (2009) Applying operational research techniques to the reorganisation of mental health care in the UK, *In: Lubicz,M*. ed., *Operational Research Applied to Health Services in Action*; pp:155-162, ISBN: 978-83-7493-409-1

18. Gallivan, S (2009) Applying mathematical methods to problems associated with health care, *In: Lubicz,M*. ed., *Operational Research Applied to Health Services in Action*; pp:65-80, ISBN: 978-83-7493-409-1

19. El-Darzi E, Abbi R, Vasilakis C, Gorunescu F, Gorunescu M, Millard P (2009) Length of stay-based clustering methods for patient grouping, *In: Intelligent Patient Management* **189:** 39-56, ISBN: 978-3-642-00178-9

20. Vasilakis C, Wilson APR, Fiorentino F, Utley M (2009) Does patient-specific risk adjustment lead to different conclusions on the occurrence of surgical wound infections? *Journal of Hospital Infection* **72(1):**179-181

21. Treasure, T (2009) Are randomised trials needed in the era of rapidly evolving technologies? *European Journal of Cardio-thoracic Surgery* **35(2009):**474-479

22. Treasure, T (2009) Commentary: The big question remains unanswered, *British Medical Journal* **338**:759

23. Tsang V T, Brown K L, Synnergren M J, deLeval M R, Kang N, Gallivan S, Utley M (2009) Monitoring risk-adjusted outcomes in congenital heart surgery: Does the appropriateness of a risk model change with time? *The Annals of Thoracic Surgery.* **87(2):** 584-587

24. Tsang V, deLeval M, Utley M (2009) Paediatric cardiac surgery, centre size, and outcomes *Scandinavian Cardiovascular Journal.* **43:** 4-6

25. Okello C, Treasure T, Nicholson AG, Peto J, Møller H (2009) Certified causes of death in patients with mesothelioma in South East England, *BMC Cancer*. **9**:28

Members of CORU also contributed to the following reports produced by the National Confidential Enquiry into Patient Outcome and Death

26. Deaths in Acute Hospitals: Caring to the End? (2009)
NCEPOD

27. Acute Kidney Injury: Adding Insult to Injury (2009)
NCEPOD

Tom Treasure contributed to the Balliol collaboration, which produced the following publications

28. Ergina P L, Cook J A, Blazeby J M, Boutron I, Clavien P A, Reeves B C , Seiler C M, for the Balliol Collaboration (2009) Challenges in evaluating surgical innovation, *The Lancet,* **374(9695):** 1097-1104

29. Barkun JS, Aronson JK, Feldman LS, Maddern G J, Strasberg S M, for the Balliol Collaboration (2009) Evaluation and stages of surgical innovations, *The Lancet,* **374(9695):** 1089-96

30. McCulloch P, Altman D G, Campbell W B , Flum D R , Glasziou P, Marshall J C , Nicholl J, for the Balliol Collaboration (2009) No Surgical innovation without evaluation: the IDEAL recommendations, *The Lancet,* **374(9695):** 1105-1112

Forthcoming publications

31. Gallivan S, Pagel C, Utley M (forthcoming) Simple sums and useful products, *Proceedings of the 34th meeting of the European working group on Operational Research Applied to Health Services*, *Toronto, July 2008*

32. Pagel C, Utley M, Gallivan S, Vasilakis C, Richards D (forthcoming) Working at capacity: modelling a generic mental health care service, *Proceedings of the 34th meeting of the European working group on Operational Research Applied to Health Services, Toronto, July 2008*

33. Tako A, Kotiadis K and Vasilakis C. (forthcoming) Developing a conceptual modelling framework for stakeholder participation in simulation studies, *Proceedings of the 5th Operational Research Society Simulation Workshop (SW10)*

34. Pepper J, Golesworthy T, Utley M, Chan J, Skandadas G, Lamperth M, Raad M, Treasure T (forthcoming) Manufacturing and placing a bespoke support for the Marfan aortic root: description of the method and technical results and status at one year for the first ten patients, *Interactive CardioVascular and Thoracic Surgery*

35. Treasure T, Treasure J. (forthcoming) Smoking cessation, *British Medical Journal*

36. Treasure T. (forthcoming) Surgery for mesothelioma: MARS landing and future missions, *European Journal of Cardio-thoracic Surgery*

37. Pagel C, Costello A, Utley M (forthcoming) Community-based interventions to reduce maternal mortality - Authors' reply, *The Lancet*

38. Fiorentino F, Hunt I, Teoh K, Treasure T, Utley M (forthcoming) Pulmonary metastasectomy in colorectal cancer: a systematic review and quantitative synthesis, *Journal of Royal Society Medicine*

39. Azad K, Barnett S, Banerjee B, Shaha S, Khan K, Roselyn Rego A, Barua S, Flatman D, Pagel C, Prost A, Ellis M, Costello A (forthcoming) The effect of scaling up women's groups on birth outcomes in three rural districts of Bangladesh: a cluster-randomised controlled evaluation, *The Lancet*

40. Tripathy P, Nair N, Barnett S, Mahapatra R, Borghi J, Rath S, Rath S, Gope R, Mahto D, Sinha R, Lakshminarayana R, Patel V, Pagel C, Prost A, Costello A (forthcoming) Effect of a participatory intervention with women's groups on birth outcomes in Jharkhand and Orissa, India: the EKJUT cluster-randomised controlled trial, *The Lancet*

41. Treasure T, Utley M (forthcoming) Cardiothoracic surgery, in Ed. Boutron I, Randomized clinical trials of non-pharmacological treatments, Taylor and Francis

42. Primrose J, Treasure T, Fiorentino F (forthcoming) Lung metastasectomy in colorectal cancer: is this surgery effective in prolonging life? *Respirology*

43. Numerous authors including Treasure T, Fiorentino F, Utley M (forthcoming) Supplement on pulmonary metastasectomy, *Journal of Thoracic Oncology*

44. Prost A, Pagel C, Costello A (forthcoming) Community interventions to reduce maternal and child mortality in low income countries (book chapter), *Royal College of Obstetricians and Gynaecologists*

45. Treasure T (forthcoming) The evolution of aortic root surgery for Marfan syndrome, *Interactive CardioVascular and Thoracic Surgery*

Selected presentations 2009

1. Outcomes in Malignant Pleural Mesothelimoa, YOR16, York, 24 – 26 March 2009

2. Modelling to test assumptions concerning the benefit of thoracic surgery, CORS/INFORMS International, Canada, 14 – 17 June 2009

3. Evaluating diagnostic tests, CORS/INFORMS International, Canada, 14 – 17 June 2009

4. You can't get there from here - reflections on an unlikely career in OR, CORS/INFORMS International, Canada, 14 – 17 June 2009

5. Tackling maternal mortality: a mathematical model to help evaluate the impact of different interventions, 23rd European Conference on Operational Research, Bonn, Germany, 4 – 8 July 2009

6. Operational Research to support the development of triage protocols for use in determining access to paediatric intensive care in the context of pandemic influenza, 23rd European Conference on Operational Research, Bonn, Germany, 4 – 8 July 2009

7. Development of an impact assessment tool to assist emergency planning within strategic health authorities, ORAHS 2009, Leuven, Belgium, 12 – 17 July 2009

8. Is mathematics good for your health? University of the Third Age, Richmond, 30 September 2009

Working with the best: our collaborators

The contributions of our clinical collaborators and academic partners are essential to CORU's research. In 2009 we benefited in particular from collaborations with

Professor Nick Barber	London School of Pharmacy
Professor Bryony Dean Franklin	Imperial College Healthcare NHS Trust
Professor Henrik Møller	Kings College London
Professor Dave Richards	The University of Exeter
Mr Victor Tsang	Great Ormond Street Hospital for Children
Dr Peter Wilson	University College London Hospital
The Thoracic Unit	Guy's Hospital
Professor Anthony Costello	UCL Institute of Child Health
Dr Audrey Prost	UCL Institute of Child Health
Dr Kate Brown	Great Ormond Street Hospital for Children
Dr Kate Bull	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	St George’s Hospital
Ms Carol Tan	St George’s Hospital
Dr Paula Lister	Great Ormond Street Hospital for Children
Dr David Cunningham	Central Cardiac Audit Database

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