Imperial College London

Introduction to mathematical models of the

Epidemiology & Control of Infectious Diseases

An interactive short course for Public Health Professionals, since 1990

Taught by leading researchers who advise policy-making internationally

HIV, TB, malaria, pandemic influenza, health economics, vaccination programmes, stochastic models and more.

6 - 17 September 2010

Directed by:

Prof Christophe Fraser
Dr Tim Hallett
Dr Tom Churcher

Lecturers include:

Prof Sir Roy Anderson FRS FMedSci
Prof Christl Donnelly
Prof Neil Ferguson OBE FMedSci
Prof Geoff Garnett
Prof Azra Ghani
Prof Brian Spratt CBE FRS FMedSci
Prof Joanne Webster

Department of Infectious Disease Epidemiology
Imperial College London
Incorporating:
- MRC Centre for Outbreak Analysis & Modelling
- Schistosomiasis Control Initiative
- UNAIDS Epidemiology Reference Group secretariat

A School of Professional Development Programme

INTRODUCTION

In recent years our understanding of infectious disease epidemiology and control has been greatly increased through mathematical modelling. Insights from this increasingly important, exciting field are now informing policy-making at the highest levels, and playing a growing role in research. The transmissible nature of infectious diseases makes them fundamentally different from non-infectious diseases, so techniques from 'classical' epidemiology are often invalid and hence lead to incorrect conclusions - not least in health-economic analysis.

Mathematical modelling now plays a key role in policy making, including health-economic aspects; emergency planning and risk assessment; control-programme evaluation; and monitoring of surveillance data. In research, it is essential in study design, analysis (including parameter estimation) and interpretation.

With infectious diseases frequently dominating news headlines, public-health and pharmaceutical-industry professionals, policy makers, and infectious disease researchers, increasingly need to understand transmission patterns and to interpret and critically-evaluate both epidemiological data, and the findings of mathematical modelling studies. Recently there has been rapid progress in developing new models and analysis techniques for outbreaks and emerging epidemics, such as influenza A (H1N1) and SARS. A simple but powerful new technique for assessing the potential of different methods to control an infectious-disease outbreak was recently developed by course presenters.

Since 1990, this course has “demystified” mathematical modelling and kept public-health professionals, policy makers, and infectious disease researchers up-to-date with what they need to know about this fast-moving field, taught by individuals who are actively engaged in research and who advise governments, international organisations, public-health agencies and pharmaceutical companies, on topics including pandemic influenza, SARS, HIV, TB and foot-and-mouth disease.

The Department of Infectious Disease Epidemiology, Imperial College London has been the world leader in mathematical modelling of the epidemiology and control of infectious diseases of humans and animals in both industrialised and developing countries for 20 years. It hosts the MRC Centre for Outbreak Analysis & Modelling, UNAIDS Epidemiology Reference Group secretariat, Partnership for Child Development and the Schistosomiasis Control Initiative that, to date, has treated over 40 million children for Neglected Tropical Diseases. This multi-disciplinary department publishes frequently in Nature, Science, Lancet, PNAS, AIDS and other leading journals. It has developed models of influenza A (H1N1), avian influenza, SARS, HIV, TB, foot-and-mouth-disease, vector-borne diseases including malaria and flariasis, helminth infections, childhood vaccine-preventable infections, sexually-transmitted infections, drug-resistant bacterial infections and others.

COMMENTS FROM PREVIOUS PARTICIPANTS

“Exceeded my expectations. Excellent.”
“The best CPD training I have ever received.”
“The course was what I expected and more, it adjusts to all levels, by the time you complete the course you have a good understanding of modelling and a love for it.”
“I feel a lot more confident in reading modelling papers now.”
“This is a must if you are dealing with infectious diseases.”
“A comprehensive course with training delivered by experts.”
“Fantastic interaction with faculty, students, post docs and support staff.”

Past participants have included hospital clinicians, senior public health executives, health economists, veterinary researchers, biologists, and mathematicians; they have come from 48 countries, both developed and developing.

COURSE AIMS

This course will enable you to:

- Understand the key concepts of infectious-disease transmission and control and the differences with non-infectious diseases - taught by people who apply those concepts every day.
- Learn how modelling informs policy-making, from case-studies presented by the individuals who advise public health professionals and governments, nationally and internationally, including during outbreaks.
- Learn about developments at the cutting edge, taught by leaders of the field.
- Read modelling papers to critically-evaluate and interpret their findings.
- Understand how different control measures (e.g. vaccination, treatment, isolation, quarantine, travel restrictions) will be effective - or ineffective - for different diseases.
- Explore models of different types of infectious disease, including TB, SARS, HIV, and vector-borne diseases.
- Design and use simple but powerful models, using Excel or Berkeley Madonna (licence included in the course fee).
- Collaborate effectively with mathematical modellers.

WHO SHOULD ATTEND

The course caters for:

- Policy-makers, public-health and disease-control professionals who need to
  (i) set appropriate goals for, and monitor performance of, infection-control programmes;
  (ii) interpret the findings of mathematical modelling studies; or
  (iii) question modelling experts effectively.
- All who need to apply modern methods of analysis in the epidemiology and control of infectious diseases, in medical, veterinary and conservation contexts.
- Health economists who need to develop appropriate models of infectious-disease control programmes.
- Researchers who need experience of using modern quantitative approaches to infectious disease epidemiology.
- Professionals planning for the control of a deliberately or accidentally released pathogen.
- Mathematicians who wish to learn key biological concepts and how they are translated into modelling.

WHAT MATHEMATICAL ABILITY IS REQUIRED?

Participants only need a *very basic mathematical ability* (high school level is more than sufficient): since most participants do not use maths regularly, if at all, we introduce concepts gently, step-by-step, and we offer the reassurance of an optional 'maths refresher' day. Calculation is done using Excel and the user-friendly modelling package, Berkeley Madonna; hence manipulation of equations is not required. We emphasise how to express biological and clinical principles in a model, and how to interpret results from a biological and clinical perspective.

OPTIONAL FREE MATHS AND EXCEL REFRESHER DAYS

In addition to the support that we offer throughout the course, we also offer an optional free maths refresher days on Sunday 5 September that some participants may wish to attend to refresh their memories. We shall also be running a free Excel refresher session on Sunday 12 September where delegates are introduced to the latest version of the programme and can learn techniques that will help them with the project work of week two.

Cover picture shows Global Distribution of Schistosomaisis. Source: WHO

COURSE CONTENT & METHODS

The course has been developed since 1990, both at Imperial College London and the University of Oxford, by a leading research team with extensive experience of advising policy-makers, including in real-time outbreak situations. It is designed to satisfy the growing demand for a thorough, but short, introduction or update of the essential elements and practically-relevant aspects of infectious disease epidemiology. It is updated annually to reflect the most recent developments in the field. Diseases covered include influenza A (H1N1), avian influenza, SARS, HIV, TB, MRSA, and malaria and other vector-borne diseases.

Teaching is interactive, with the key concepts introduced in lectures. Most of the learning takes place in computer practicals, question-and-answer sessions and small-group discussions of key topics and published papers. These are designed to encourage reflection and consolidation of the key concepts.

In the first week, the basic conceptual, mathematical, statistical and computational tools needed for a rigorous approach to infectious disease epidemiology are introduced. Keynote lectures and case studies covering a wide range of topics place the current use of mathematical modelling in context, illustrating how it contributes to epidemiological studies, policy-making and evaluation. The focus of the second week is on extended, in-depth, hands-on, small-group projects, complemented by lectures addressing practical case studies.

This course does not merely illustrate some models, but rather we maximise your learning by helping you to make your own and apply them to real-world data, for example data from the 2003 outbreak of SARS in Hong Kong.

Every participant is allocated a computer with internet access throughout the course and is given an extensive course manual and a licensed copy of the user-friendly modelling package, Berkeley Madonna, to take away, along with all the models used and developed on the course. There is no formal assessment but a certificate of attendance is issued.

The course has been approved by the Royal College of Physicians for 50 Continuing Medical Education credits.

Social events include a trip on the London Eye followed by a dinner banquet and a buffet lunche with department staff. There are numerous opportunities to participate in informal social activities within a very friendly department.

Approval sought for 50 Continuing Medical Education credits

TOPICS

Core Topics

Introduction of the fundamental principles, including basic model structures for different diseases. How model equations are constructed to reflect biology (e.g. modes of transmission, whether immunity occurs or not). How age structure and heterogeneity in risk behaviour or disease susceptibility are incorporated. How the basic reproduction number is calculated. Stochastic and spatially-explicit models are also explained.

Special Topics

- Vector-borne diseases: a multi-species ecosystem.
- The herd effect in infectious disease epidemiology.
- Planning mass vaccination campaigns.
- Hospital-acquired infections: where stochasticity rules.
- Interactions between infectious diseases

Practical Classes

These lead you step-by-step through simple models

- Designing a model of tuberculosis transmission.
- Programming your first model in *Berkeley Madonna.*
- Estimating key parameters from an outbreak of influenza.
- Exploring heterogeneous behaviour in a model of sexually transmitted diseases.
- A stochastic model of nosocomial MRSA.

Keynote lectures

- Mathematical models and infectious diseases: successes of the past and challenges for the future
- Health economics of infectious disease control.
- Interventions against HIV.
- The Schistosomiasis Control Initiative.
- Vaccination against sexually-transmitted infections.
- Schistosomiasis: from models to data.
- Seasonality of infectious diseases.
- BSE and vCJD: Mad cows and Englishmen.
- HIV, UNAIDS and models for a global pandemic.
- Bacterial genetics, epidemiology and evolution.
- Bovine TB: science, policy and dogma.
- Pandemic Influenza planning.
- Preparing for future infectious disease threats.
- Using models in planning clinical trials.

Projects

We help you develop your own models, to really consolidate your learning

- HIV/AIDS: Antiretroviral therapy and HIV transmission in a developing country context.
- Malaria & human onchocerciasis.
- SARS: real-time response to the 2003 Hong Kong epidemic.
- Avian influenza.

For an up-to-date programme and to apply visit

www.infectiousdiseasemodels.org

GENERAL INFORMATION

To Apply

To apply please upload a copy of your CV and a covering letter briefly outlining your background and explaining your reasons for wanting to attend the course to **http://www.infectiousdiseasemodels.org/book**. Applications to the course are normally reviewed in three batches as follows,

I. Received between 8 January and 31 March 2010 - notified by 7 April 2010

II. Received between 1 April and 30 June 2010 - notified by 7 July 2010

III. Received between 1 July and 20 August 2010 - notified as soon as possible, but before 27th August.

However, if you need to know whether you will be offered a place sooner, then please indicate this in the cover letter.

When your application has been processed you will be notified if you have been successful or not. If you have been successful we will ask you to pay the course fee.

Detailed registration instructions, including a map, will be sent to all participants one month prior to the commencement of the course.

Last year's course was oversubscribed. Places on the course are limited, early booking is strongly advised.

Fees

The fee is £1950 for bookings made before 30 June 2009 or £2250 for bookings made after 30 June 2009. The optional maths refresher on 5 September and Excel refresher on 12 September are free of charge. The fee covers tuition, a comprehensive set of course notes, a licensed copy of the Berkeley Madonna modelling package, light refreshments and a course reception but does not cover other meals or accommodation.

Please note that your place will only be confirmed when payments have been received.

Venue

The course will be held in a dedicated facility at the Department of Infectious Disease Epidemiology at Imperial College London. This is located at the St Mary's Campus in Paddington.

Accommodation

Single bedroom accommodation is available in local hotels within easy access to the St Mary's Hospital Campus. Minimum cost of a room with shower/bath will be in the region of £95 per night. Student accommodation at the South Kensington campus is also available from £49 per night. This is additional to the course fee, and participants are responsible for payment of their hotel bills.

For further details and reservations, please contact:

Imperial College London
Accommodation Link
South Kensington Campus
London SW7 2PG
Tel: +44 (0)20 7594 9507/11; Fax: +44 (0)20 7594 9504/5;

Information is available at: www.imperial.ac.uk/conferences

Visas

Overseas delegates requiring Visas for the UK are responsible for their application and should allow sufficient time for the process to be completed.

Cancellations

A 20% administration fee will be charged for cancellations made up to four weeks prior to the start of the course. Cancellations thereafter will be liable to the loss of the full fee. Notice of cancellation must be given in writing by letter or fax and action will be taken to recover, from the delegates or their employers, that proportion of the fee owing at the time of cancellation.

The College reserves the right to cancel an advertised course at short notice. It will endeavour to provide participants with as much notice as possible, but will not accept liability for costs incurred by participants or their organisations for the cancellation of travel arrangements and/or accommodation reservations as a result of the course being cancelled or postponed. If a course is cancelled, fees will be refunded in full. The College also reserves the right to postpone or make such alterations to the content of a course as may be necessary.

Queries

Technical queries should be directed to:

Dr Tim Hallett and Dr Tom Churcher

Department of Infectious Diseases Epidemiology
Imperial College London
St Mary's Campus
London W2 1PG, UK.
Email: infectiousdiseasemodels@imperial.ac.uk

Queries regarding registration and other administration matters should be directed to:
Marta Kowalewska

School of Professional Development
Imperial College London
South Kensington Campus
London SW7 2PG. UK.
Tel: +44 (0)20 7594 6884
Fax: +44 (0)20 7594 6883
Email: cpd@imperial.ac.uk

PRESENTERS INCLUDE:

Professor Sir Roy Anderson FRS FMedSci
Professor of Infectious Disease Epidemiology

Prof Anderson's research interests are in epidemiology, transmission dynamics and control of a wide variety of infectious agents, ranging from HIV, via the parasitic infections, to livestock diseases such as SARS, Foot and Mouth and BSE. He is co-author with Robert May of the text book "Infectious diseases of humans: transmission dynamics and control" Oxford University Press (1991), and has published extensively on many different aspects of infectious disease transmission, evolution and control.

Professor Christl Donnelly
Professor of Statistical Epidemiology

Prof Donnelly's research interests are in the synthesis of statistical and biomathematical methods for the analysis of epidemiological patterns of infectious diseases. She is particularly interested in the epidemiology of Tasmanian Devil Facial Tumour Disease, SARS, transmissible spongiform encephalopathies - TSEs - (particularly BSE, vCJD and scrapie), foot and mouth disease (FMD), bovine TB (in cattle and badgers) and HIV/AIDS.

Professor Neil Ferguson OBE FMedSci
Professor of Mathematical Biology
Director, MRC Centre for Outbreak Analysis & Modelling
Member, UK Science Advisory Group for Pandemic Influenza Planning
Member, Science Advisory Council for UK Dept. of Environment, Food and Rural Affairs

Prof Ferguson has a broad interest in the epidemiology, population dynamics, and evolution of infectious diseases, and in developing statistical techniques for analysing disease data. His research includes work on influenza, SARS, antigenically-variable pathogens, foot and mouth disease, BSE and vCJD, HIV and bioterrorist agents. Recent work has particularly focused on outbreak modeling and pandemic preparedness.

Professor Geoff Garnett
Professor of Microparasite Epidemiology
Chair, UNAIDS Reference Group on Estimates, Modelling & Projections

Prof Garnett's main research focus is on the epidemiology of sexually transmitted infections, including patterns of risk behaviour and the design of interventions. In particular, he is interested in the impact of interventions to prevent HIV spreading in developing countries. He is also studying the potential impact of STD vaccines and the interpretation of surveillance data for HIV and STDs.

Professor Azra Ghani
Professor of Infectious Disease Epidemiology
Member, UK government's Spongiform Encephalopathy Advisory Committee

Prof Ghani's research combines the use of mathematical models and statistical methods to explore the impact of interventions against infections of humans and animals, with a focus on results which can inform policy. She has in the past worked on a range of infectious diseases including sexually transmitted infections/HIV, BSE/vCJD, SARS and influenza. Her current focus is on developing and applying models to inform malaria control and elimination

Professor Brian Spratt CBE FRS FMedSci
Head, Department of Infectious Disease Epidemiology

Prof Spratt has worked on the mechanism of action of penicillin and identified the physiological targets of penicillin action (penicillin-binding proteins). He has also worked on resistance to ß-lactam antibiotics, particularly resistance mediated by alterations of the penicillin-binding proteins. Currently he is interested in the evolutionary and population biology of major bacterial pathogens and in multilocus sequence-based methods for the unambiguous characterisation of major bacterial pathogens on the internet (MLST).

Professor Joanne Webster
Professor of Parasite Epidemiology & Royal Society University Research Fellow

The main focus of Prof Webster's research is to identify and characterise the mechanisms and implications of host-schistosome coevolution, through a combination of both large scale field-based studies across Africa and Asia, and tightly controlled experiments and manipulation within the laboratory. She is also the Director of research surveillance for the Schistosomiasis Control Initiative. In addition, Prof Webster is involved in a range of other host-parasite interaction studies, including that on *Toxoplasma gondii* and bovine tuberculosis.

Professor Christophe Fraser
Professor in Theoretical Biology & Royal Society University Research Fellow
Deputy Director, MRC Centre for Outbreak Analysis & Modelling

Prof Fraser's research interests are broadly in infection dynamics and evolution. He has an active interest in infectious disease outbreak dynamics, the likely impact of public health measures and methods for the rapid estimation of key parameters. He has recently worked on SARS, influenza, HIV and polio. He is also interested in bacterial population genetics, and the interface between evolution and epidemiology.

Dr Daren Austin
Honorary Research Fellow and Clinical Pharmacologist at GlaxoSmithKline

Dr Austin's research interests focus on the use of mathematical models to predict the outcome for outbreaks in small settings. He is particularly interested in the dynamics of hospital outbreaks of resistant organisms, which are highly transmissible and often difficult to control. These "nosocomial" or hospital-acquired infections have received considerable attention in the media. As a Clinical Pharmacologist he works on the development of therapeutic monoclonal antibodies, where he heads a group responsible for clinical trial design and prediction of therapeutic regimens primarily in the treatment of inflammatory disease.

Dr María-Gloria Basáñez
Reader in Parasite Epidemiology

Dr Basáñez's research interests are the population biology and epidemiology of arthropod-borne infectious diseases, in particular human onchocerciasis; helminth epidemiology and control; and the synthesis of field data, plus statistical analysis. She is also using mathematical modelling to further understand the population dynamics of macroparasites and the effect of control interventions on these dynamics.

Dr Marie-Claude Boily
Senior Lecturer in Infectious Diseases Ecology

Dr Boily's research interests focus on the use of empirical and mathematical modelling studies to measure and evaluate preventive intervention for infectious diseases. Her projects aim to better understand STI and HIV/AIDS transmission and assess the impact of interventions. It also involves the innovative use of mathematical models to validate and improve study design and analysis of epidemiological or clinical trial studies before they are implemented in the field.

Dr Simon Cauchemez
Research Councils UK Research Fellow

Dr Cauchemez is interested in the statistical analysis of outbreak data, with a view to better understanding transmission dynamics. He has evaluated the impact of school closure on influenza epidemics using incidence data and the timing of holidays. He also investigates transmission dynamics in small communities (e.g. influenza transmission in households) and developed mehtods to monitor the efficacy of control measures in real time.

Dr Nicholas Grassly
Reader in Infectious Disease Ecology & Royal Society University Research Fellow

Dr Grassly is interested in identifying and estimating behavioural, biological and environmental parameters important for observed dynamics of infectious diseases. A central theme is the analysis of routine disease surveillance data using mathematical models and statistical methods to test hypotheses about disease transmission and the effectiveness of control. His research aims to be relevant to policy, with a particular focus on sexually transmitted infections, polio and trachoma.

Dr Peter White
Health Protetion Agency/ Lecturer in Infectious Disease Epidemiology

Dr White's research interests are in sexually-transmitted infections, HIV, and TB, in the UK, Peru and USA. He collaborates with the University of Washington, Seattle; UCSD; UCLA; UPCH, Lima, Peru; University College London; King's College London; the US Centers for Disease Control and Prevention (CDC), the UK Health Protection Agency and others, on projects funded by the Wellcome Trust, MRC, NIH and others.

Dr Tom Churcher
Research Fellow

Dr Churcher's research focuses on the use of mathematical models to understand the epidemiology and control of vector borne infections such as malaria and filariasis. Of particular interest is the development of models merging population dynamics with population genetics to explore the evolutionary response of the parasite to control interventions.

Dr Tim Hallett
Henry Wellcome Postdoctoral Fellow

Dr Hallett works on the epidemiology of HIV, mostly in sub-Saharan Africa. Current primary research interests are in the evaluation of large-scale interventions, epidemic surveillance, combination prevention interventions and estimating the future course, cost and demographic impact of the epidemic.

Dr Deirdre Hollingsworth
Research Fellow

Dr Hollingsworth uses mathematical models to inform the design of effective interventions to control malaria She also investigates the role of variability in life history in the transmission of HIV and the resulting implications for evolution and control.

See website for a complete list:

www.imperial.ac.uk/cpd/epidemiology