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, neglected tropical diseases, vaccination programmes, stochastic models and more.

5 - 16 September 2011

Directed by:
Prof Christophe Fraser
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 exciting and increasingly important 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 often invalidating techniques from 'classical' epidemiology leading 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. The course is taught by individuals who are actively engaged in research and who advise governments, international organisations, public health agencies and pharmaceutical companies.

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 multidisciplinary 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 filariasis, 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 adjusts to all levels, by the time you complete it you have a good understanding of modelling and a love for it.”
• “This is a must if you are dealing with infectious diseases.”
• “Extremely high quality of lectures, materials, support and overal organisation. Very intensive but worth the brainwork!”
• “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 from high and low income countries.
COURSE AIMS

Taught by leaders of the field who advise public health professionals and governments, nationally and internationally, the course will explore:

- The key concepts of infectious-disease transmission and control and the differences with non-infectious diseases
- How different control measures (e.g. vaccination, treatment, isolation, quarantine, travel restrictions) will be effective or ineffective for different diseases
- Models of different types of infectious disease, including TB, SARS, HIV, and vector-borne diseases
- The design and use of simple but powerful models, using Excel or Berkeley Madonna (licence included in the course fee).

This will be supported by ongoing discussion and debate including exploring how modeling informs policy making; the critical evaluation and interpretation of modelling papers and how best to effectively collaborate 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 (see below). 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 day on Sunday the 4th of September and a free Excel refresher session on Sunday the 11th of 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.
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.

In 2010 the course was 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 lunch 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.
- Modelling macroparasitic infections
- 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.

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.
- 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.
- Bovine 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
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.

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 2011 or £2250 for bookings made after 30 June 2011. The optional Maths refresher on 4 September and Excel refresher on 11 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 Tom Churcher
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London W2 1PG, UK.
Email: infectiousdiseasemodels@imperial.ac.uk

Queries regarding registration and other administration matters should be directed to:
Marta Kowalewska
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Tel: +44 (0)20 7594 6884
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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 bioinformatics methods to inform 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 Ghanli
Professor of Infectious Disease Epidemiology
Member, UK government’s Spongiform Encephalopathy Advisory Committee
Prof Ghanli’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 β-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 mutlicious 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 Francois Balloux
Reader in Infectious Disease Epidemiology
Dr Balloux’s main research projects focus on the interplay between the geographic distribution of human pathogens and that of human disease resistance/susceptibility genes. He has also developed models of disease outcome/progression taking into account the genetic makeup of the pathogen and the host as well as key demographic factors of the patient such as age and sex.

Dr Maria-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 methods 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, polo and trachoma.

Dr Peter White
Health Protection 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 Churchill
Research Fellow
Dr Churchill’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, epidemi 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