EPIDEMIOLOGY AND CONTROL OF COMMUNICABLE DISEASES
Department of Infectious Disease Epidemiology

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This module aims to introduce concepts, methods, and challenges arising in the epidemiological research and practical control of communicable diseases. Though the module's emphasis will be on diseases arising from infections with pathogens that are transmitted directly between humans, we follow *Heymann et al* (2015) in using the term "communicable diseases" to include all diseases attributable to microbial and parasitic agents.

MODULE STRUCTURE

The material is organised in three themes, which overlap and reinforce each other. The first two weeks will provide you with a foundation in basic concepts and theory related to analytical methods and vaccine evaluation. The third week will allow you to apply your learning as you work in assigned teams to investigate simulated outbreaks. During the final two weeks, which focus on current issues in communicable disease epidemiology, you will have the opportunity to learn more about some of the major diseases, including malaria, HIV/STIs, and tuberculosis, as well as new challenges stemming from emerging infections and drug resistance.

OPTIONAL SESSIONS

In the second week of the module, you will have the opportunity to learn about vaccines and their evaluation. If you have not previously studied vaccines or taken "Extended Epidemiology" in Term 1, we recommend that you attend the "Basic" vaccine evaluation sessions, which introduce the concept of vaccine efficacy and provide an overview of methods for estimating it. If you are already familiar with these concepts, we recommend that you attend the "Advanced" vaccine evaluation sessions, which address a variety of more complex issues arising in the evaluation of both beneficial and detrimental aspects of vaccination. Both sessions will prepare you equally well for the final exam.

In the third week of the module, you will be working as part of a team to study an outbreak based in either an African setting or a European setting. Based on the information you have provided in the pre-module questionnaire, we have assigned you to an outbreak and tried to balance the investigative teams with respect to students' skillsets and interests.

READING & PREPARATION

There is a large literature on epidemiological methods and issues related to infectious diseases. References are included on many of the session handouts, and we have also listed some epidemiology texts with useful infectious disease-related material below. *Please note: While the reading lists are provided to you as an additional resource, the lectures, slides, and practical notes contain all of the material considered essential for this study unit.*

1. **CONTROL OF COMMUNICABLE DISEASES MANUAL.** Edited by DL Heymann, WHO and APHA, 20th Edition, 2015. *Excellent disease orientated handbook containing key information on the epidemiology and control of virtually all the communicable diseases.*
2. **A DICTIONARY OF EPIDEMIOLOGY.** M Porta, JM. Last, Oxford University Press, 6th edition, 2014. *Just what the title says – but human orientated and some of the definitions are wrong (especially, unfortunately, relating to infectious diseases!). We hope one of you will compose a better dictionary someday.*
3. **COMMUNICABLE DISEASE CONTROL HANDBOOK**. J. Hawker, N Begg, I Blair, R Reintjes, J Weinberg, 2nd edition, 2005, Blackwell Publishers. *Useful, European slant – includes description of infectious disease control institutions in all countries in Europe.*
4. **COMMUNICABLE DISEASES – A GLOBAL PERSPECTIVE.** R Webber. 4th Edition CABI, 2012. *Tropical developing country emphasis, descriptive, good on life cycles.*
5. **MODERN INFECTIOUS DISEASE EPIDEMIOLOGY**. J. Giesecke, Edward Arnold, 2nd edition 2002. *A good introductory epidemiology text concentrating strictly on infectious diseases. It was written at LSHTM and covers a good deal of the material in this study unit*.
6. **INFECTIOUS DISEASE EPIDEMIOLOGY: THEORY AND PRACTICE.** KE Nelson and CM Williams. Jones and Bartlett Pub, 3rd edition, 2014. *The text is more than 950 pages, with around 400 pages on general principles, then chapters on groups of diseases.*
7. **THE PATHOGENESIS OF INFECTIOUS DISEASE**. A. Nash, R Dalziel, J Fitzgerald. Academic Press, 6th Edition, 2015. *Useful book on the natural history of infections, including some basic immunology.*
8. **INFECTIOUS DISEASES OF HUMANS: DYNAMICS AND CONTROL** R. M. Anderson and R. M. May, Oxford University Press, 1991. *A classic compilation of work on modelling the dynamics of infections in populations. Some tolerance of mathematics is a prerequisite!*
9. **AN INTRODUCTION TO INFECTIOUS DISEASE MODELLING** E Vynnycky and RG White, Oxford University Press 2010. *A good introduction to modelling, updating Anderson and May by 20 years.*
10. **EPIDEMIOLOGIC METHODS FOR THE STUDY OF INFECTIOUS DISEASES.** Edited by JC Thomas, DJ Weber, Oxford University Press, 2001. *USA slant with some useful sections.*
11. **CONTROLLING COMMUNICABLE DISEASE**, N Noah, Open University Press 2006. *Practical, orientated mainly to UK / Europe, good teaching questions.*

Please plan to bring along a calculator for practical sessions. Some students find it helpful to work through the practical exercises in advance of their discussion in class.

For the immunoepidemiology session, you may find it helpful to brush up on your logarithms beforehand. A refresher is included at the end of this document.

FEEDBACK & EVALUATION

We value your feedback and want to help you to get the most out of this module. As the course progresses, please feel free to discuss the content and conduct of the module with any of the three organizers. We also encourage you to provide feedback in the formal evaluation; we take this evaluation seriously and are constantly striving to improve ECCD.

ASSESSMENT

Assessment will be based on a group outbreak investigation report (20%) and an individual multiple-choice exam (80%).

1. For the outbreak investigation, the class will be divided into groups, each of which will devise a questionnaire, interview cases, analyse data, and prepare a report. Marks will be given to each group based on the quality of the report. General marking criteria are provided in Table 1. Marking criteria specific to the European and African outbreak scenarios will be distributed in the team outbreak packs.

Table 1. General marking guidelines

Grade	Range	Descriptor	General Criteria
5	≥80	Excellent	A comprehensive discussion of the topic giving all relevant information, showing in-depth critical understanding of the topic, going beyond conventional answers, and bringing in additional relevant ideas or material.
4	70-79	Very good	A full discussion of the topic that includes all relevant information and critical evaluation.
3	60-69	Good	The major points are discussed, but relevant, though less important considerations, are omitted.
2	50-59	Satisfactory	Sufficient relevant information is included but not all major points are discussed, and there may be some errors of interpretation.
1	40-49	Unsatisfactory/ poor (fail)	A few points are included, but lack of understanding is shown together with use of irrelevant points.
0	<40	Very poor (fail)	None of the major points present; many irrelevant points included and a serious lack of understanding.

2. The multiple-choice exam (9.30-11 am Friday, 23rd March) will include material *from all the sessions*, but not outside reading. For each question, you will need to select the single best answer from a list of 5 possible answers. The questions are designed to test your epidemiological understanding, not just rote memorization. You should learn equations (these are not complex), but you will not be asked about historical dates and details. The questions are not designed to deliberately catch you out. Each question is worth the same number of marks. All questions will be answerable whether you have taken the basic or the advanced vaccine session. You should attempt to answer all of the questions.

   Bring a calculator to the exam (not one on a mobile phone, which you cannot use during the exam). You will also need to bring a pen or pencil and your candidate number.

   You might have heard in previous years that there was 'negative marking' on the ECCD exam. **There will not be any negative marking on the 2018 ECCD MCQ exam.** This means that you will get one mark for each correct answer and zero marks for any incorrect answer, any questions left blank, or any questions where you select more than one answer.

The top of the page of the exam will look like this:

DIRECTIONS:
1. There are 52 questions.
2. *CIRCLE* the letter for the *SINGLE* best answer to each question.
3. Scoring: Correct answer = + 1.00
Left blank or more than one answer = 0.00
Wrong answer = 0.00
4. You have 1.5 hours
5. Good luck!

WRITE YOUR LSHTM CANDIDATE NUMBER HERE……

Example Questions

1. The average (serial) interval between two successive cases of an infectious disease

a. is always longer than the average incubation period
b. is always shorter than the average incubation period
c. is the same as the average incubation period
d. is the same as the average duration of infectiousness (infectious period)
e. may be influenced by the extent of exposure to the first case

2. If p is the risk of infection over one year, then the risk of infection over two years is
a. 2p
b. p^2
c. $2(1 – p)$
d. $1 – (1 – p)^2$
e. $1 – p^2$

3. " Core groups" are particularly important in the transmission of

a - Influenza viruses
b - STIs
c - Scarlet fever
d - Malaria
e – Chickenpox

4. A case control study of pertussis found that that the odds of being vaccinated among disease cases were 0.40 times the odds of being vaccinated among controls. From this we can say that the vaccine efficacy

a - is approximately 0.40
b - is approximately 0.60
c - is approximately 0.67
d - is approximately 0.33
e - cannot be calculated

SESSION OVERVIEW

1. INTRODUCTION TO THE EPIDEMIOLOGY OF INFECTIOUS DISEASES

This session introduces the language of infectious diseases, providing a glossary of terms that will arise repeatedly throughout the study unit. The common language is a means to bring together course participants, who come from a wide variety of backgrounds.

2. CONTAGION OR MIASMA – IS THIS AN INFECTIOUS DISEASE?

This session covers a variety of methods to help infer whether a disease has an infectious aetiology. This is a deep and recurrent problem in infectious disease epidemiology, as some diseases that were long thought not to have infectious causes have turned out to reflect unusual infectious agents or unusual outcomes of common infections.

3. INFECTION TRANSMISSION DYNAMICS

This session introduces basic principles of transmission dynamics using historical, descriptive and simulation modelling of transmission processes. Concepts include: threshold, mass action, deterministic versus stochastic modelling, epidemic threshold, case reproduction number, basic case reproduction number, epidemic cycles, herd immunity threshold, Reed Frost model, "at least one" logic, and probability of effective contact.

4. TRANSMISSIBILITY OF INFECTIONS

This session presents the two general approaches to describing transmissibility of infections. It covers the subtleties of secondary attack rates, provides several approaches for estimation of basic case reproduction numbers, and discusses the relationship between the two different types of measures.

5. MOLECULAR EPIDEMIOLOGY

This session will examine the way in which the genetic make-up of pathogens can be used to help understand the epidemiology of infectious diseases. These methods are becoming increasingly widely used. The lecture will use the West African Ebola outbreak to illustrate the methods and their application. The lecture will be followed by a large group practical that will bring in further examples.

6. PRINCIPLES OF INFECTIOUS DISEASE AND VACCINE IMMUNOLOGY

This session begins by introducing basic immunological principles that are crucial to many aspects of infectious disease epidemiology, pathogenesis, diagnosis, and control. It then moves to discuss the properties of vaccines and how these make use of the immune mechanisms to protect against disease.

7. VACCINES AND VACCINATION PROGRAMMES

This session provides a brief history of vaccination, describes global approaches to vaccination, and introduces some of the key concepts in vaccination including coverage, consent, and contraindications.

8. VACCINE EVALUATION

These sessions (basic and advanced) describe methods for evaluating efficacy, impact and safety of vaccines. The basic session uses vaccines to review the basic principles of epidemiology (e.g., cross sectional, cohort, case control, and trial logic). The advanced session assumes thorough familiarity with these methods as taught in the Extended Epidemiology course in the first term.

9. IMMUNOEPIDEMIOLOGY

This session introduces a variety of issues and methods applicable to the collection and analysis of immunological data on a population basis. Some of the methods involve logarithms, and thus a primer is included in the manual to assist in revising the basic properties of logarithms. The last part of the lecture is devoted to a synthesis of measures, which have arisen in various contexts during this and other courses (risks, rates, probabilities, forces of infection, Poisson probabilities, Reed Frost measures, and catalytic models).

10. OUTBREAK INVESTIGATION

The outbreak investigation provides hands-on experience in the main steps of outbreak investigation, including questionnaire design, interviewing, data entry, cleaning and analysis, and report writing. The exercise is *mandatory* and contributes to 20% of your overall mark.

11. ANTIMICROBIAL RESISTANCE AND HOSPITAL-ACQUIRED INFECTIONS

This session is an introduction to two important public health topics, looking at causes and spread**.** The lecture is followed by a small group practical examining some examples in more detail.

12. HIV AND OTHER SEXUALLY TRANSMITTED INFECTIONS

This lecture covers the special properties of sexually transmitted infections, emphasising the particular characteristics of STI agents and the importance of behaviour in determining social, geographic, and temporal trends. The practical explores several of the methodological issues that arise in analysing data on STIs.

13. TUBERCULOSIS

The lecture covers the underlying biology of tuberculosis, including: infection transmission, immune responses, pathogenesis, and the main approaches to control (BCG vaccination, case finding and treatment, including the "DOTS" and "DOTS-Plus" concepts). It touches upon molecular epidemiology and drug resistance, both of which are major themes in tuberculosis and also with many other infections.

14. EMERGING INFECTIOUS DISEASES

This lecture discusses the factors contributing to the emergence of new infections and provides recent examples and approaches to their surveillance.

15. INFECTIOUS DISEASES AND GLOBAL HEALTH DIPLOMACY

This lecture aims to provide a snapshot of the infectious disease situation worldwide and to introduce the key technical and political instruments used to form global health policy.

16. EPIDEMIOLOGY AND CONTROL OF MALARIA

This lecture and discussion will be broad, moving from biology to epidemiology to global health politics, touching upon the work of Ross and Macdonald (at LSHTM) and upon the major international initiatives to control this important disease.

17. INFECTIOUS DISEASE SURVEILLANCE & BURDEN ESTIMATION

Estimation of the frequency and disease burden associated with infectious diseases is a crucial activity for targeting research and control efforts. This session will discuss the methods and hazards of these measurement enterprises and is taught as a large group lecture including interactive exercises.

18. ELIMINATION AND ERADICATION OF INFECTIOUS DISEASES

This session presents the history of large scale infectious disease elimination and eradication programmes and provides arguments both for and against them. The second half of the session allows an open debate of the epidemiological and political issues surrounding current and future large scale infectious disease eradication initiatives.

19. INFECTIOUS DISEASE CONTROL IN PRACTICE

This session provides case studies from Médecins Sans Frontières.

A QUICK REFRESHER ON LOGARITHMS

The ECCD session on immunoepidemiology refers to logarithms in a few places. This sheet is to help remind you of the basic properties of logarithms.

1) The logarithm that may be most familiar to you is the logarithm to the base 10 (also known as $\log_{10}$).
   Because $10^2 = 100$, $\log_{10} 100 = 2$.
   (Think: If $a^b = c$, then $\log_a c = b$, where "a" is the "base" of the logarithm.)

2) Two other kinds (i.e., bases) of logarithms are frequently used in epidemiology and immunology:
   a) "Natural logarithms" use the base "e" and are widely used in epidemiology. Natural logs may be written as $\log_e$ or as ln. The letter "e" represents a mathematical constant with special properties that is approximately equal to 2.71828.
   b) Logarithms to the base 2 are frequently used to describe serial two-fold dilutions. Two-fold dilutions are a means of reducing a concentration by half at each step. For example, if a suspension is diluted by half three times in a row, the resulting concentration is 1/8 of the original: ½ x ½ x ½ = 1/8 = $1/2^3$. (Think: $\log_2 8 = 3$.)

3) Please also remember that:
   a) Any number to the "power" (or "exponent") of 1 equals itself.
      For example, $3^1 = 3$ and $10^1 = 10$.
      Similarly, $\log_3 3 = 1$ and $\log_{10} 10 = 1$.

   b) Any number raised to the power of 0 equals 1.
      For example, $3^0 = 10^0 = 1$.
      Similarly, $\log_{10} 1 = \ln 1 = \log_2 1 = 0$.

4) Multiplication of numbers implies addition for exponents and logarithms.
   For example, $4 \times 8 = 2^2 \times 2^3 = 2^{(2+3)} = 2^5 = 32$.
   In general, that means $\log (c \times d) = \log c + \log d$.

   Similarly, $\log a^2 = \log (a \times a) = \log a + \log a = 2 \log a$.
   Thus, in general, $\log a^b = b \log a$.

   For example, $\log_{10} 100{,}000 = \log_{10} 10^5 = 5 \log_{10} 10 = 5 (\times 1) = 5$.

   As another example, try $\log_e 100{,}000 = 11.512925$.
   Thus, $\log_e 100{,}000 = \log_e 10^5 = 5 \times \log_e 10 = 5 (2.3025851) = 11.512925$.