UNIVERSITY OF CAMBRIDGE

The Cambridge Healthcare Data Programme

"The future of healthcare is an informatics game"

Healthcare Data: Informatics, Innovation and Commercialization

Part-time courses for professionals

Postgraduate Certificate, Diploma and Master's Levels

UNIVERSITY OF CAMBRIDGE
Institute of Continuing Education

Cambridge Healthcare Data Hub

UNIVERSITY OF CAMBRIDGE
School of Clinical Medicine

Cambridge Biomedical Campus

NHS Cambridge University Hospitals NHS Foundation Trust

CAMBRIDGE UNIVERSITY Health Partners
Knowledge-based healthcare

EMBL-EBI

Introduction

This course represents a widely held desire to develop a truly novel, innovative way to fill a skills gap in healthcare data and we are very proud of the course we have been able to develop and the interest it has received.

Naturally, we want the course to be inspiring, practically applicable, and challenging but we also sincerely hope that the networks that the course creates will provide an enduring, global community who share an ethos about the use of healthcare which will drive improvements in patient care, drug discovery, social policy, and commercial innovation.

Cambridge is a world leader in research and innovation in patient and clinical trial data. It is also probably fair to say that the opportunities presented by the abundance of healthcare data have not been fully realised, both in the sense of healthcare quality and research but also commercial activity and innovation.

This course is designed to blend a comprehensive approach to understanding data and how it can be extracted, analysed, and visualised, with learning in a systems engineering approach to change management *and* a business focussed approach to innovation and entrepreneurship. We are very proud of the wide partnership we have been able to build when developing the course.

Our sincere hope is that this course does not produce coders and informaticians, but that it produces experts who are able to see where healthcare data sits within a wider health and social landscape, and who can use data to deliver value in healthcare, research, and commercial arenas.

Please read this prospectus for more information about the programme.

Dr Ronan O'Leary

Course Director

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Programme and Partners

The Cambridge Healthcare Data Programme provides award-bearing, part-time courses from the University of Cambridge. Our programme advances skills in transforming raw healthcare data into effective tools which can be deployed in research, quality improvement, or commercial arenas.

Available at Postgraduate Certificate, Diploma and Master's levels, the courses provide training in the practical interrogation and commercialization of healthcare data for those wanting to become health informaticians.

Cambridge is a world-leading centre for innovation in electronic patient and clinical trial data. This is underpinned by an extensive and vibrant community of clinicians, researchers, entrepreneurs, and commercial and public sector organisations. In response to a growing skills gap in the sector, the healthcare data programme has been developed by:

Cambridge University Hospitals, NHS Foundation Trust

University of Cambridge School of Clinical Medicine

Department of Engineering, University of Cambridge

University of Cambridge Institute of Continuing Education (ICE)

Cambridge University Health partners (CUHP)

Cambridge Judge Business School (CJBS)

The East of England has recently been designated by NHSX as one of seven Health Data Research Hubs with a focus on Inflammatory Bowel Disease. Whilst the Lead organisation is **Cambridge University Hospitals NHS Foundation Trust**, the Hub is a rich collaboration of institutions and organisation from the region and nationally.

The Cambridge Biomedical Campus is unmatched within the UK, and perhaps across the world, in terms of concentration of clinical, academic, educational, technology, pharmaceutical, and biosciences organisations. It is located at the heart of the UK's and Europe's leading life sciences cluster. The CBC contains the **University of Cambridge School of Clinical Medicine** with its 12 Departments and associated Institutes, Cambridge University Hospitals, a major University Teaching Hospital with 1100 beds, and a number of directly funded research institutes.

Cambridge University Health Partners is one of six Academic Health Sciences Centres in England, recognised by the Department of Health as an internationally leading centre of excellence. The CUHP Partners are Cambridge University Hospitals NHS Foundation Trust, Cambridge and Peterborough NHS Foundation Trust, Royal Papworth Hospital NHS Trust and the University of Cambridge. By inspiring and organising collaboration, CUHP aims to ensure patients reap the benefits of the world class research, bespoke educational programmes, clinicians, and industry based on the CBC and surrounding area.

The **Institute of Continuing Education (ICE), University of Cambridge**: Continuing education has been part of the University's work since the 1870s and the University remains committed to the principle of providing opportunities for learning throughout life. The Institute of Continuing Education is an academic department of the University and is the focus for this work. Students study on part-time courses which range from

weekend residential courses to full MSt degrees. Madingley Hall is the University of Cambridge's campus dedicated to continuing education for adults. The magnificent Hall was built in the sixteenth century and acquired by the University in 1948. The Hall has been used by the Institute of Continuing Education as a venue since 1975.

The **Department of Engineering** is one of the few truly integrated engineering departments in the world. The research portfolio develops pinnacles of world-class excellence, which adapt and combine to address a vast array of engineering challenges. Graduate teaching brings students into the heart of the latest research and developments. Across research, teaching and graduate study, the Department of Engineering offers all its staff, students and industry partners a highly networked community for sharing and developing engineering knowledge.

Cambridge Judge Business School is in the business of transformation - of individuals, of organisations and society. The School work with students and organisations at a deep level, identifying important problems and questions, challenging and coaching people to find answers, and creating new knowledge. Bringing forward the latest thinking from academia and professional practice, they apply their combined knowledge to specific business situations to turn it into action. The School achieves excellence in the quality of their research insights and educational engagement, developing knowledge both for its own sake and to help others make a difference. This combination of the latest thinking from academia and professional practice, in turn, enables them to develop greater knowledge and better methods in order to have an impact on the world in which we live and work.

The EMBL-European Bioinformatics Institute (EMBL-EBI) is part of the European Molecular Biology Laboratory (EMBL), Europe's flagship laboratory for the life sciences. Supported by EMBL's 20 member states and two associate member states, its 500 members of personnel come from > 40 countries. The Institute is based at the Wellcome Genome Campus home to some of the world's foremost institutes and organisations in genomics and computational biology.

Venues used for delivery of the programme:

Over the duration of the course the following venues may be used, these will be confirmed at the start of the course:

Institute of Continuing Education
Madingley Hall
Madingley
Cambridge, CB23 8AQ
Website: http://www.ice.cam.ac.uk/

Cambridge Biomedical Campus
Hills Road
Cambridge CB2 0SP
Website: www.medschl.cam.ac.uk

European Molecular Biology Laboratory's European Bioinformatics Institute [EMBL-EBI]
Wellcome Genome Campus
Hinxton Cambridge CB10 1SA

EMBL-EBI website: https://www.ebi.ac.uk/
Wellcome Genome Campus website: https://www.wellcomegenomecampus.org/

Key People

The programme is led and taught by an experienced and skilled faculty team along with specially selected external lecturers and industry specialists, including:

Course Leads

Programme Director: **Arun Gupta,** Director of Postgraduate Medical Education, Cambridge University Hospitals NHS Foundation Trust.

Course Director: **Ronan O'Leary,** consultant in neurosciences and trauma intensive care medicine, and education lead for neurosciences and trauma critical care in Cambridge.

Academic Director: **Dr Tom Monie,** protein biochemist, assistant director of academic centres (Academic) and the Academic Director for STEM (Biological) Sciences at the Institute of Continuing Education.

Unit Leads

Unit 1: Dr Sarah Morgan
Scientific Training Coordinator, EMBL-EBI

Unit 2: Dr Afzal Chaudhry
Chief Medical Information Officer and Consultant Nephrologist, Cambridge University Hospitals NHS Foundation Trust
Associate Lecturer, University of Cambridge

Unit 3: Matt Castle
Head of the GSLS Biostatistics Initiative, University of Cambridge

Unit 4: Professor John P Clarkson
Director, Cambridge Engineering Design Centre.

Unit 5: Dr Chris Coleridge
Director, Cambridge Judge Launchpad, Senior Faculty, Cambridge Judge Business School

Administrative Lead

Head of Academic Centre Administration: Gillian Barclay

Aims of the Cambridge Healthcare Data Programme

The programme has been designed to provide an introduction to the research skills, governance and innovation needed to work successfully with healthcare data. In addition students will be equipped with the skills necessary to understand how healthcare data relates to populations, health conditions and clinical outcomes and learn how to work with healthcare data in an effective manner.

The programmes have been developed by a network of partners with unrivalled experience in healthcare informatics to create a world-leading training environment. They will develop individuals with the necessary knowledge and skills to be able to understand and critically evaluate electronic healthcare data and its application for healthcare research.

The programme will:

- Provide professionally relevant teaching and learning of the knowledge and skills at the forefront the successful understanding and utilisation of electronic healthcare data.
- Develop healthcare data experts with the necessary expertise, and originality of application, to pursue and expand their roles in the rapidly evolving environment of healthcare data.
- Promote a comprehensive understanding of the practical and ethical considerations relevant to healthcare data and informatics.
- Ensure a systems-based approach to the critical analysis and development of improvements in healthcare systems.
- Provide work-relevant learning around the current problems, best-practice, challenges and potential solutions in the use of healthcare data.
- Create a professional network of like-minded individuals as leaders in the field of healthcare data.
- Provide students with the skills and knowledge to make value-based judgements around how to extract, refine, and structure data to permit effective healthcare research.

Programme Structure

The Healthcare Data: Informatics, Innovation, and Commercialization is a part-time programme designed to fit with the demands of full-time employment. The course is delivered through a combination of face-to-face and sessions requiring attendance in Cambridge, online sessions and self-directed learning and the course is supported through a virtual online environment [VLE].

Please note that course delivery will be reviewed in line with the latest public health guidance available at the time. If required, to ensure the health and safety of students, we may look to utilise alternative teaching formats and will contact students if we expect changes to the course delivery

The programme leads to the following University of Cambridge degrees or awards:

- ### Postgraduate Certificate (PgCert) in Healthcare Data and Informatics
  A one-year part-time Master's level programme resulting in 60 FHEQ (Framework for Higher Education Qualifications) level 7 credits and a University of Cambridge award (**Units 1 and 2**).

- ### Postgraduate Diploma (PgDip) in Healthcare Data: Informatics, Innovation and Commercialization
  A two-year part-time Master's level programme resulting in 120 FHEQ level 7 credits and a University of Cambridge award (**Units 1 to 5**).

- ### Master of Studies (MSt) in Healthcare Data: Informatics, Innovation, and Commercialization
  A two-year part-time Master's level programme resulting in 180 FHEQ level 7 credits and a University of Cambridge degree (**Units 1 to 5 and Unit 6, a research dissertation**).

Course Units

The programme is structured across the following six units of study:

Unit	Description	Credit Allocation
Unit 1	Research skills, governance and innovation	20 credits

Unit 2	Data structures, storage and queries	40 credits
Unit 3	Finding relationships and data visualisation	20 credits
Unit 4	Healthcare systems improvement	20 credits
Unit 5	Medical technology innovation and commercialization	20 credits
Unit 6	Dissertation	60 credits

Each 20 credits of study is roughly equivalent to 200 hours of study which will consist of face-to-face teaching, blended, and self-directed learning. This is an indicative amount and it is recognised that individuals may engage in greater or lesser amounts of study for each unit.

Course Overview

Academic year 1: October 2021 - June 2022		
Unit 1 - Research Skills, Governance, and Innovation ***(20 Credits)***		
Start Date	4 October 2021	Madingley Hall and The Wellcome Genome Campus
Teaching Week	4 – 8 October 2021	
Unit 2: Data Structures, Storage and Queries ***(40 Credits)***		
Unit 2: Week 1		
Start Date	3 January 2022	Cambridge Biomedical Campus
Teaching Week	10 – 14 January 2022	
Unit 2: Week 2		
Start Date	4 April 2022	Cambridge Biomedical Campus
Teaching Week	4 – 8 April 2022	
Academic year 2: October 2022 - July 2023		
Unit 3: Finding Relationships and Data Visualisation ***(20 Credits)***		
Start Date	3 October 2022	Madingley Hall
Teaching Week	10 – 14 October 2022	
Unit 4: Healthcare Systems Improvement ***(20 Credits)***		
Start Date	2 January 2023	Madingley Hall
Teaching Week	16 – 20 January 2023	
Unit 5: Medical Technology Innovation and Commercialization ***(20 Credits)***		
Start Date	11 April 2023	Madingley Hall
Teaching Week	24 – 28 April 2023	
Unit 6: Research Dissertation ***(60 credits)***		
Deadline	31 July 2023	Madingley Hall

****Please note that teaching dates and venues are provisional and may be subject to change in accordance with government/University guidelines***

Unit Descriptions

Unit 1: Research Skills, Governance and Innovation (20 Credits)

Unit 1 provides the landscape to understand the breadth of patient level data in the healthcare and economic landscape in the UK and globally. It provides knowledge of the technical, legal, and ethical infrastructure which guides all research, commercial development, and healthcare quality improvement. Furthermore, it introduces key concepts from subsequent parts of the course to allow students to develop their thinking around systems engineering, statistics and data visualisation, and innovation. Students will be taught by a faculty of experts from genomics, clinical medicine, informatics, statistics, business, and engineering. Masterclass sessions will use case studies to examine the impact of healthcare data.

Content

Indicative content for this module includes:

- An introduction to healthcare data and its importance
- Overview of local, national and global initiatives for healthcare data application
- Principles of good data management / stewardship
- Open vs closed data and the FAIR principles
- Governance of healthcare data use
- Principles of quality healthcare data research
- Basic data manipulation (data visualisation)
- An introduction to systems engineering approaches using healthcare data
- An introduction to innovation and commercialization

Learning Outcomes

By the end of the units the participants should be able to:

- Describe the breadth of healthcare data available and the potential for its use in clinical innovation
- Discuss appropriate data management requirements for a healthcare data set, including storage and access
- Apply appropriate ethical and governance guidelines in the acquisition and use of healthcare data
- Plan a basic piece of research on a healthcare dataset
- Outline how the results of a piece of research can be communicated to appropriate groups to support implementation of change
- Know the basic principles of the systems engineering approach and routes to innovation and commercialisation

Unit 2: Data Structures, Storage and Queries (40 Credits)

Unit 2 is a 40 credit unit, the largest in the programme, and delivers all of the health informatics training needed for students to be able to independently design and execute queries of raw electronic patient record data. The practical aspects of the unit will focus on the Epic system but the theoretical components will take a platform agnostic approach to covering data structures and healthcare database design. Students completing this unit will be competent in the use of the programming and scripting languages which are used globally to analyse healthcare data. Faculty will be drawn from clinical informaticians, researchers, and

commercial sector software experts. Masterclasses will explore the practical aspects of patient level data extraction and analysis.

Content

Critical awareness of the wider implications, relationships, and impact of healthcare data (25%)

- How are populations and diseases reflected in datasets?
- Where and how does healthcare data impact policy and infrastructure development?
- How do hospitals and other organisations use data?
- What opportunities does healthcare data offer hospitals and other organisations?

Data and database structures, storage, quality, access and governance (25%)

- How is data stored, in what ways do databases differ?
- How do trial registries, clinical research, and audit databases differ from electronic patient records?
- Where is data stored, particularly in the UK health and research sectors?
- What is the appropriate governance surrounding access for healthcare data?
- Documentation standards, data quality and the implications for interoperability and secondary use.

Data-extraction and curation (50%)

- Converting research and quality improvement questions into database queries
- Writing and executing SQL database queries and related quality control
- How is a dataset ideally constructed for subsequent analysis?

Learning Outcomes

By the end of this module participants should be able to:

- Describe the various types / properties / structure / usage of multiple types of patient-level and aggregated data used in the field of healthcare
- Describe the framework within which datasets are described, mandated / notified, implemented and reported in the NHS.
- Describe the UK governance framework relating to the use of personal data in healthcare
- Describe the differences between terminologies and classifications and their usage
- Describe an approach to data stewardship and proper curation in the management of healthcare data
- Describe the elements which underpin meaningful and safe interoperability in the context of personal healthcare data
- Evaluate a request for data, demonstrating an understanding of all of the factors / aspects to be considered including governance, structure / quality and extraction methodology
- Formulate a high-level approach to a database query from a specific data (research / audit etc.) question
- Write appropriate SQL queries and extract data from a normalised database
- Demonstrate the ability to transform / curate extracted data in preparation for more detailed analysis

Unit 3: Finding Relationships and Data Visualisation (20 Credits)

The ability to visualise results of healthcare data research and quality improvement projects is essential yet is rarely taught. Moreover, design theory and practice is uncommonly included within health informatics courses. Unit 3 is an entirely novel, innovative approach to teaching statistics and data visualisation as it applies to healthcare data and will allow the clear presentation and explanation of novel information arising from patient level data projects. The unit will use real healthcare data datasets to develop understanding of practical statistics primarily using R. Students will also be taught design and visualisation theory and practice, and tools to enhance their ability to present results from large datasets in clear, interesting, and visually appealing ways. Faculty will be drawn from statisticians, data scientists, genomic scientists, and graphic design experts.

Content

Indicative content for this module includes:

- An overview of data visualisation theory
- Development of visualisation critical skills
- Training in Python graphical modules including plotly, seaborn and plotnine
- An overview of classical statistical techniques from simple hypothesis testing through to generalised linear models and power analysis
- Training in Python statistical modules
- An overview of statistical reporting

Learning Outcomes

By the end of the units the participants should be able to:

- To understand core aspects of visual design theory and use them to critically evaluate and construct data visualisations
- To utilise Python to create appropriate static visualisations of healthcare data
- To apply core statistical techniques to data using Python in order to identify statistically significant relationships and patterns
- To be able to produce a short, technically accurate statistical report for a small healthcare dataset

Unit 4: Healthcare Systems Improvement (20 Credits)

Healthcare faces considerable challenges and the complexity of the system mean that efforts to improve it often achieve only limited benefits and frequently have unforeseen consequences. Over the past two decades, there have been numerous calls to implement a systems approach to transform healthcare; however, there has been no clear definition of what this might mean. Engineers routinely use a systems approach to address challenging problems in complex projects and this allows them to work through the implications of each change for the project as a whole. They consider the layout of the system, defining all the elements and interconnections, to ensure that the whole system performs as required. This module will apply a systems engineering approach to the process of data-driven change in healthcare environments allowing students to understand and measure the consequences of any change introduced due to analysis of complex healthcare datasets. This unit will enable students to understand healthcare systems before making data-driven changes. This will allow students to become experts in balancing the differing needs of users, assessing risk, and then implementing change and assessing effectiveness of system change within hospitals, pharmaceutical companies, and health research charities.

Content

Indicative content for this module includes:

- Engineering Better Care – introducing the concept of a systems approach.
- Mapping Systems – describing the architecture and behaviour of systems.
- Managing Risk – delivering robust system risk assessment and evaluation.
- Enabling Creativity – facilitating the delivery of the 'right' systems solution.
- Improving Improvement – supporting a systems approach to improvement.

Learning Outcomes

By the end of the units the participants should be able to:

- Appreciate the importance of people, systems, risk and design perspectives within improvement.
- Understand the role of data-flow diagrams, influence maps and rich pictures in mapping systems.
- Understand the value of FMEA, SWIFT and bowtie methods in the management of system risk.
- Understand the use of requirements, morphological charts and measures to drive system design.
- Plan the application of a systems approach to a data-driven healthcare improvement project.

Unit 5: Medical Technology Innovation and Commercialization (20 Credits)

In Unit 5, we will look at a range of skills required for innovation. Firstly, we will examine the difference between "entrepreneurial" and "intrapreneurial" opportunities and the paths entrepreneurs and intrapreneurs need to walk. Secondly, we will consider the range of business models currently fashionable and interesting in the medtech data space, and how this range of business models may evolve over time. Finally, we will investigate the question of medtech innovation strategy—how medium and large players in the medtech space manage their innovation portfolios and the implications for individual innovators. By the end of the unit, students should have a good grasp of the choices in front of them in terms of commercialization, and the critical success factors for successful innovation.

Content

Indicative content for this module includes:

- Evaluating and ranking a range of ideas for innovations
- Applying their understanding of entrepreneurial project selection to a basic "pitch structure" for a venture
- Applying their understanding of corporate innovation portfolios to the preparation of an "investment case" for a project.
- Analysing a range of current business models in the space and assessing their likelihood of leading to market entry and market power
- Analysing a range of value propositions in the space and making recommendations for improving them

Learning Outcomes

By the end of the units the participants should be able to:

- Evaluate opportunities for innovation, considering customer, stakeholder and financial perspectives.

- Assess whether entrepreneurial or intrapreneurial approaches are more appropriate for a given opportunity
- Understand the financial underpinning of entrepreneurial ventures and how investors evaluate and select ventures to invest in
- Understand how corporate innovation strategies within medical technology and healthcare lead to the selection and development of a portfolio of innovation projects
- Deconstruct business models into their component pieces and understand the relationship of the business model to market entry and market power
- Construct and evaluate value propositions and understand the role of data within such value propositions
- Understand the critical components of an early stage entrepreneurial venture and the typical pathways to assembling them
- Understand the typical pathways to the initiation of a corporate innovation project and the navigation by individual project managers of the stages of such projects.

Unit 6: The Research Dissertation (60 Credits)

For MSt students only:
During Year 1 of study the main focus will be on the successful completion of course work, but it will be important to think about the dissertation in preparation for year 2.

Assessment

Essays, projects and written papers

Units 1-5 will use summative assessment approaches designed to ensure experiential learning and work-based real-life relevance. Approaches may include, but are not limited to: critical analysis of case-studies, assessment of evidence-based portfolios, assessment of work and sector relevant group presentations and projects, short answer questions, essays, and the ability to handle, analyse and visualise unseen datasets.

Generally, the assessments are released at the end of each teaching week and the submission date is approximately 8 weeks later.

The Dissertation (*MSt students only*)

Unit 6 is the research dissertation. Most work will be done in the second year of study and students are required to achieve a pass mark in order to receive the award of Master of Studies.

Attendance and participation

Attendance at all of the units in Cambridge and online is compulsory and full and active participation in all elements of the course is expected.

Supervision and Feedback

Students will receive formative and peer-based feedback throughout the course, along with tutor provided feedback on the submitted summative assignments. During the first year and the taught modules, the primary responsibility for supervision of students lies with the module leaders and Course Director.

MSt students will have a dissertation supervisor assigned who will provide guidance on their research project for Unit 6.

Madingley Hall and Cambridge Colleges

Our Postgraduate Certificate and Diploma students should see Madingley Hall as their Cambridge course home. Madingley Hall is a beautiful venue and you will be welcome to spend time there, use the facilities and our library.

- Madingley Hall, Institute of Continuing Education

MSt students become a member of a Cambridge College. For the MSt in Healthcare Data we have an arrangement with the Colleges below to accept our students. You will be asked to select your preference at point of application although both these Colleges have been selected in recognition of their particular support for part-time students.

- Homerton College
- Wolfson College

It may be possible to become a member of an alternative College should an applicant have a previous affiliation. However, we believe (and feedback from previous students tells us) that students have a more positive experience as part of a College group.

How To Apply

Applications will be accepted online until 20 May 2021.

Entry Requirements

Academic requirement

Applicants for this course are expected to have achieved a UK 2.i honours degree or equivalent.

It is preferred that an applicant's first degree be in a subject relevant, or related to, life sciences, medical sciences, computational or data science.

Language requirement

- IELTS Academic: Overall score of 7.0 (a minimum of 7.0 in Listening, Writing and Speaking; 6.5 in Reading)
- TOEFL Internet: Overall score of 100 (a minimum of 25 in each individual component)
- CAE: Grade A or B (with at least 193 in each individual element), plus a Language Centre assessment
- CPE: Grade A, B, or C (with at least 200 in each individual element)

Fees for Academic Year 2021 to 2022

Course	Home/EU	Overseas fee
Postgraduate Certificate in Healthcare Data	£5,152	£9,452
Postgraduate Diploma in Healthcare Data	£10,304	£18,904
Mst in Healthcare Data	£15,456	£28,356

Other costs

Students will be expected to cover the application fee (£70 online) and any costs of travel, accommodation and subsistence during the teaching weeks in Cambridge. Please note that students will require the use of a laptop for the duration of the course.

Documents required in support of application

In addition to completing an online application, applicants will be asked to provide:

- Academic transcripts
- Two references
- A Curriculum Vitae (CV)
- Evidence of competence in English (if appropriate)

Selection process

- Stage 1: Applications are reviewed by the course team after the application closing date.
- Stage 2: Selected applicants will be invited for interview
- Stage 3: Conditional offers for places will be made approximately 4-6 weeks after the application closing date.

Further information:

For admission specific enquiries

Admissions Team - Institute of Continuing Education
University of Cambridge
Madingley Hall, Madingley
Cambridge
CB23 8AQ
United Kingdom
Email the admissions team at: admissions@ice.cam.ac.uk
Tel: +44 (0)1223 746262

For general and course related enquiries

Healthcare Data Course Team - Institute of Continuing Education
Madingley Hall
Madingley
Cambridge
CB23 8AQ
United Kingdom
Email the programme team at: healthcaredata@ice.cam.ac.uk