Stefano Aliberti, Amy Farr, Nathalie Tabin, Francesco Blasi, Antoni Torres, Mark Woodhead, Giovanni Battista Migliori, Giovanni Sotgiu, George Dimopoulos, James D. Chalmers, Felix C. Ringshausen, Michael R. Loebinger, Robert Read, Gernot Rohde

gernot.rohde@kgu.de

@ERStalk

For a full list of the authors' affiliations please see the Acknowledgements section.

ERS syllabus for postgraduate training in respiratory infections: a guide for comprehensive training

Introduction

Respiratory infections, including tuberculosis, represent one of the leading causes of morbidity and mortality across the world. They represent the deadliest communicable diseases causing 3.0 million deaths worldwide in 2016 [1]. The burden of respiratory infections can be unbearable for some health systems: they represent one of the most common reasons for doctor visits, regardless of age and sex [2].

Although respiratory infections have been identified as a mandatory topic in the education and training of respiratory physicians, the specialty has been faced with several challenges to implement training. There are ongoing discussions surrounding what is included and excluded epidemiologically within the parameters of respiratory infections. Thus it is no surprise that, at present, the vast majority of European countries do not yet have a formal system for educating respiratory physicians, at a specialty level, on the knowledge and skills considered essential in the diagnosis, treatment and prevention of respiratory infections. Furthermore, European countries have very different resources dedicated to the continuing development of respiratory professionals.

Keeping these educational and training challenges in mind, the European Respiratory Society (ERS) decided to support a group of experts in respiratory infections to define the core knowledge and skills considered essential to manage respiratory infections. The ERS respiratory infections educational task force was founded in 2014 and included 13 experts from six European countries (Italy, Germany, UK, the Netherlands, Spain and Greece). The task force had two main aims: 1) to develop a syllabus to guide the national training and education of respiratory physicians in the field of respiratory infections, and 2) to help structure ERS educational activities on respiratory infections.

Cite as: Aliberti S, Farr A, Tabin N, *et al*. ERS syllabus for postgraduate training in respiratory infections: a guide for comprehensive training. *Breathe* 2018; 14: 269–275.

@ ERSpublications
ERS has developed a syllabus for postgraduate training in respiratory infections to guide programme designers http://ow.ly/xJ0R30m8CYB

Table 1 *ERS syllabus for postgraduate training in respiratory infections*

Module 1. Pathogens (respiratory microbiology)	
1 Respiratory microbiology	Mandatory
1.1 Normal bacterial flora	
1.2 Classification of respiratory microorganisms	
2 Respiratory bacteria	Mandatory
2.1 Gram positive	
2.2 Gram negative	
2.3 Atypicals	
3 Respiratory viruses	Mandatory
3.1 RNA viruses (seasonal and/or pandemic, emerging)	
3.2 DNA viruses (seasonal and/or pandemic, emerging)	
4 Respiratory fungi	Mandatory
4.1 *Candida* spp.	
4.2 *Aspergillus* spp.	
4.3 Pneumocystis	
4.4 Other fungi (including *Mucor* spp., *Cryptococcus neoformans*, *Histoplasma capsulatum*, *Coccidioides immitis*, *Blastomyces dermatitidis*, *Paracoccidioides brasiliensis*, Exophiala and Scedosporium)	Optional
5 Mycobacteria	Mandatory
5.1 *Mycobacterium tuberculosis*	
5.2 Non-tuberculous mycobacteria (NTM)	
6 Antimicrobial resistance	Mandatory
6.1 Mechanisms of antibiotic resistance	
6.2 Multidrug-resistant (MDR) bacteria	
6.3 Risk factors for MDR bacteria	
6.4 MDR/extensively drug-resistant (XDR) tuberculosis	
6.5 Risk factors for MDR/XDR tuberculosis	
6.6 NTM resistance	
6.7 Resistance in other microorganisms (anti-fungal and anti-viral resistance)	Optional
6.8 Influenza resistance	Optional
7 Microbiome	Optional
Module 2. Host respiratory defence mechanisms against infection	
1 Natural barriers	Mandatory
1.1 Cilia/primary ciliary dyskinesia	
2 Innate immune systems	Mandatory
2.1 Complement	
2.2 Cells	
2.3 Defensins	
2.4 Cytokines	
2.5 Inflammation process	
3 Adaptive immune systems	Mandatory
3.1 Humoral immunity	
3.2 Cellular immunity	
4 Immune reconstitution inflammatory syndrome (IRIS)	Optional

Continued

Table 1 *Continued*

Module 2. Host respiratory defence mechanisms against infection (cont.)	
5 Pathophysiology of respiratory infections	Mandatory
5.1 Transmission	
5.2 Infection	
5.3 Inflammation	
5.4 Resolution	
Module 3. Epidemiology, burden of disease and risk factors	
1 Epidemiological burden of respiratory infections	Mandatory
1.2 Bacterial infections	
1.3 Viral infections	
1.4 Fungal infections	
1.5 Mycobacterial infections (tuberculosis and NTM)	
2 Risk factors for respiratory infections and transmission	Mandatory
2.1 Environmental risk factors	
2.2 Host risk factors (including other conditions leading to mild immunosuppression, *e.g.* diabetes mellitus)	
2.3 Microbial risk factors	
Module 4. Diagnostic techniques for respiratory infections	
1 Indication and collection of biological specimens	Mandatory
1.1 Noninvasive (blood, urine, bronchoalveolar lavage, throat swabs)	
1.2 Invasive (sputum, tracheal aspirate, thoracentesis, imaging-guided biopsy, transthoracic fine-needle biopsy)	
2 Microscopy	Optional
3 Culture	Optional
4 Susceptibility testing	Optional
5 Immunological tests	Optional
5.1 Interferon-γ release assay (IGRA)	
5.2 Tuberculin skin test	
5.3 Serology	
6 Molecular testing	Optional
7 Rapid point-of-care diagnostic tests for viral and bacterial respiratory tract infections	Optional
8 Imaging techniques in relation to infections (including chest radiography, computed tomography, lung ultrasounds and magnetic resonance imaging)	Mandatory
Module 5. General principles of antimicrobial therapy	
1 Antibacterial agents	Mandatory
1.1 Classification and activity (including pharmacokinetics/pharmacodynamics (PK/PD) principles)	
2 Antiviral agents	Mandatory
2.1 Classification and activity (including PK/PD principles)	
3 Antifungal agents	Mandatory
3.1 Classification and activity (including PK/PD principles)	
4 Antimycobacterial agents	Mandatory
4.1 Classification and activity (including PK/PD principles)	
5 Drug delivery or administration	Mandatory
5.1 Oral	
5.2 Inhaled	
5.3 Intravenous	
5.4 Intramuscular	

Continued

Table 1 *Continued*

Module 5. General principles of antimicrobial therapy (cont.)	
6 Drug–drug interaction	Mandatory
7 Antimicrobial adverse events	Mandatory
7.1 Haematological side-effects	
7.2 Nausea and vomiting	
7.3 Diarrhoea including *Clostridium difficile* infection	
7.4 Ototoxicity	
7.5 Hepatic toxicity	
7.6 Nephrotoxicity	
7.7 Cardiovascular toxicity	
8 Principles of antimicrobial stewardship (including prevention of infection, infection control, adequate and appropriate treatment)	Mandatory
Module 6. Common respiratory tract syndromes	
1 Common upper respiratory tract syndromes (including acute infective rhinitis, sinusitis, pharyngitis, epiglottitis, laryngotracheitis)	Mandatory
2 Acute bronchitis	Mandatory
3 Bronchiolitis	Mandatory
4 Exacerbation of asthma	Mandatory
5 Exacerbation of chronic obstructive pulmonary disease (COPD)	Mandatory
6 Exacerbation of bronchiectasis	Mandatory
7 Community-acquired pneumonia, including nursing-home pneumonia	Mandatory
8 Nosocomial pneumonia, including ventilator-associated pneumonia	Mandatory
9 Aspiration pneumonia	Mandatory
10 Seasonal influenza	Mandatory
11 Extrapulmonary complications	Mandatory
Module 7. Other respiratory infections	
1 Fungal pulmonary infections	Mandatory
2 Lung abscess	Mandatory
3 Nocardiosis	Mandatory
4 Actinomycosis	Mandatory
5 Parasitic pneumonia	Optional
6 Travel born respiratory infections	Mandatory
Module 8. Severe viral respiratory infections	
1 Viruses	Mandatory
1.1 Severe acute respiratory syndrome (SARS), Middle East respiratory syndrome (MERS), H1N1, H5N1	
2 Pandemics	Mandatory
2.1 Identification	
2.2 Management	
2.3 Public health policies	
Module 9. Mycobacterial disease	
1 Pulmonary tuberculosis	Mandatory
2 Extrapulmonary tuberculosis	Mandatory
3 Latent tuberculosis infection	Mandatory
4 Nontuberculous mycobacterial infections	Mandatory

Continued

Table 1 *Continued*

Module 10. Chronic respiratory infections in patients with respiratory disease	
1 Asthma	Mandatory
2 COPD	Mandatory
3 Bronchiectasis	Mandatory
4 Adult cystic fibrosis bronchiectasis	Mandatory
Module 11. Pulmonary infections in the immunocompromised host	
1 Neutropenic patients	Mandatory
2 HIV-infected patients	Mandatory
3 Haematological disorders and malignancy	Mandatory
4 Lung and other solid organ transplant recipients	Mandatory
5 Haematopoietic cell transplant recipients	Mandatory
6 Secondary immunodeficiency induced by drugs and biologicals	Mandatory
7 Primary immune deficiency syndromes	Mandatory
Module 12. Pleural infections	
1 Parapneumonic effusion and empyema	Mandatory
2 Pleuritis	Mandatory
2.1 tuberculosis, bacterial, *etc.*	
Module 13. Sepsis	
1 Sepsis, severe sepsis and septic shock	Mandatory
1.1 Virulence factors involved in sepsis	
1.2 Early recognition and management	
1.3 Additional therapies	
1.4 Biomarkers	
1.5 Clinical management	
Module 14. Prevention of respiratory infections	
1 Vaccination	Mandatory
1.1 Influenza vaccination	
1.2 Pneumococcal vaccination	
1.3 Other vaccinations	
2 Other prevention measures	Optional
2.1 Smoking cessation	
2.2 Specific preventive management	
2.3 Prevention of community-acquired pneumonia	
2.4 Dental care	
2.5 Aspiration management	
3 Infection control	Mandatory
3.1 Infection surveillance	
3.2 Universal precautions	
3.3 Isolation and reverse isolation, including specific microbes in cystic fibrosis and bronchiectasis (*e.g. Pseudomonas*)	
3.4 Infectious risks to healthcare workers	
3.5 Tuberculosis control and elimination, including Bacillus Calmette–Guérin (BCG) vaccine	
3.6 Immunomodulants (synthetic and microbial)	

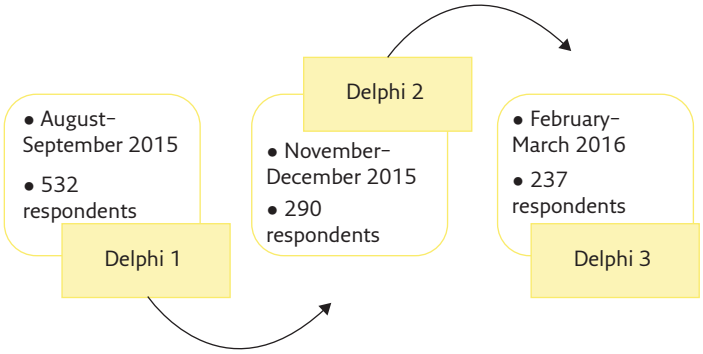

Figure 1 *Overview of the Delphi process.*

Target audience

As previously outlined [3], the target audience for the syllabus are qualified respiratory physicians with a special interest in respiratory infections. Based on the situational analysis and the Delphi surveys, the target audience also includes infectious diseases specialists, intensive care unit specialists, internists, trainees, researchers and microbiologists, working in public hospitals or holding an academic position.

Methods

The approach, methods, and processes used in this project have been adapted from the ERS developed educational harmonisation framework, which, to date, has been used in the development of seven postgraduate curricula (www.ersnet.org/professional-development/ers-curriculum-design-a-summary-of-projects) and four specialised skills-based training programmes [4].

To develop the syllabus, a list of key topics was identified by the expert task force. A modified Delphi technique was applied to these topics to reach consensus. The Delphi technique is a group facilitation method that seeks to obtain consensus on the opinions of experts through a series of structured questionnaires [5]. Research and methods outlined by Heiko [6] were used to guide the decisions taken at various stages of this study, for example survey design, undertaking data collection and analysis.

The Delphi process was phased in three rounds (figure 1). Members of ERS Assembly 10 (respiratory infections) and national experts were asked to complete an online questionnaire, which was then processed by the ERS office. The results were presented to the task force for more detailed discussion. The decisions derived from these consultations were integrated into the next Delphi round (Delphi 1). It is to be noted that although the same respondents were contacted in each round, there was a drop off in the number of responses between rounds. Respondents were asked to rate in terms of agreement whether sections should be included (mandatory or optional) or excluded. A Likert scale from 1 (strongly disagree) to 5 (strongly agree) was chosen to ensure measurement reliability over the three different Delphi rounds. Agreement was operationalised through a majority of responses in the top two points of the scale (measured as the sum of frequencies of agree and strongly agree responses). In Delphi studies consensus is considered a necessary, but not sufficient, condition for agreement concerning the inclusion of items [6]. The iteration of rounds was also required to establish the stability dimension for agreement. Stability was defined as "the consistency of responses between successive rounds of a study" [7]. Both consensus and stability dimensions were investigated in the study.

Final syllabus

The content of the syllabus was organised in 14 modules, which were considered important and necessary topics or aspects forming the basis of the respiratory infections domain (table 1).

Conclusion and next steps

The syllabus was developed to clearly define the remit for programme designers in the implementation of training and education for respiratory physicians. ERS is committed to the continuing professional development of respiratory professionals and will be using the ERS respiratory infections syllabus as a basis for several activities in the future, including:

- External courses, such as the respiratory infections course (*e.g.* the course held in Lisbon, Portugal, June 2018), postgraduate courses at the ERS International Congress, e-learning and other educational activities;
- Respipedia and other online resources;
- An ERS professional development programme, focusing on the eight main disease areas.

Acknowledgements

The task force would like to acknowledge Albert Osterhaus (Research Center for Emerging Infections and Zoonoses, University of Veterinary Medicine Hannover, Foundation, Hannover, Germany) for his work on this project.

The authors affiliations are as follows. Stefano Aliberti: Dept of Pathophysiology and Transplantation, University of Milano, Milan, Italy, and Respiratory Unit and Adult Cystic Fibrosis Center, Fondazione IRCCS

Ca' Granda Ospedale Maggiore Policlinico, Milan, Italy. Amy Farr and Nathalie Tabin: European Respiratory Society, Educational Activities Dept, Lausanne, Switzerland. Francesco Blasi: Dept of Pathophysiology and Transplantation, University of Milano, Milan, Italy. Antoni Torres: Pneumology Dept, Hospital CLINIC, University of Barcelona, IDIBAPS, CIBERE, Barcelona, Spain. Mark Woodhead: Faculty of Biology, Medicine and Health, University of Manchester, Manchester, UK. Giovanni Battista Migliori: Istituti Clinici Scientifici Maugeri IRCCS, Tradate, Italy. Giovanni Sotgiu: Clinical Epidemiology and Medical Statistics Unit, Dept of Clinical and Experimental Medicine, University of Sassari, Sassari, Italy. George Dimopoulos: Dept of Critical Care, University Hospital ATTIKON, Medical School, National and Kapodistrian University of Athens, Athens, Greece. James D. Chalmers: Dept of Respiratory Medicine, Ninewells Hospital and Medical School, Dundee, UK. Felix C. Ringshausen: Dept of Respiratory Medicine, Hannover Medical School and German Center for Lung Research (DZL), Hannover, Germany. Michael R. Loebinger: Host Defence Unit, Royal Brompton Hospital, London, UK and National Heart and Lung Institute, Imperial College, London, UK. Robert Read: Academic Unit of Infection and Immunity, University of Sheffield Medical School, Sheffield, UK. Gernot Rohde: Medical clinic I, Dept of Respiratory Medicine, Goethe University Hospital, Frankfurt/Main, Germany.

Conflict of interest

S. Aliberti has nothing to disclose. A. Farr is an employee of the European Respiratory Society. N. Tabin is an employee of the European Respiratory Society. F. Blasi has nothing to disclose. A. Torres has nothing to disclose. M. Woodhead reports an honorarium for a lecture at European Pneumoupdate in 2016, 2017 and 2018. G.B. Migliori has nothing to disclose. G. Sotgiu has nothing to disclose. G. Dimopoulos has nothing to disclose. J.D. Chalmers reports grants and personal fees from Glaxosmithkline, Grifols, Boehringer-Ingelheim and Insmed, grants from Astrazeneca and Bayer Healthcare, personal fees from Aradigm, Pfizer and Napp, all outside the submitted work. F.C. Ringshausen reports grants, personal fees and other from Bayer HealthCare (research support, consulting, lecture fees and support of patient educational events), grants and personal fees from Grifols Germany (research support and consulting), grants and personal fees from Insmed Germany (research support, consulting and reimbursement for study participation/patient recruitment), personal fees from Brahms/Thermo Fisher Scientific (consulting), personal fees from Astra Zeneca (lecture fees), personal fees and other from Forest (consulting and support of patient educational events), personal fees from Cellestis/Qiagen (lecture fees), personal fees and other from Chiesi (travel reimbursement and support of patient educational events), other from Abbott (support of patient educational events), personal fees and other from Gilead (travel reimbursement and support of patient educational events), other from Pfizer (support of patient educational events), other from Oxycare (support of patient educational events), other from Novartis (support of patient educational events), other from Heinen & Löwenstein (support of patient educational events), other from MSD (support of patient educational events), grants and other from InfectoPharm (research support and support of patient educational events), all outside the submitted work. M.R. Loebinger has nothing to disclose. R. Read has nothing to disclose. G. Rohde reports personal fees from Pfizer, Boehringer Ingelheim, Solvay, GSK, Essex Pharma, MSD, Roche and Novartis for lectures including service on speakers' bureaus outside the submitted work and/or consultancy during advisory board meeting and personal fees from GSK for travel accommodations/meeting expenses, outside the submitted work.

References

1. Global Health Estimates: Death by Cause, Age, by Country and by Region, 2000-2016. Geneva, World Health Organisation, 2018.
2. World Health Organization. World health statistics 2011. World Health Organization, 2011.
3. Niculescu A, Noel J-L, Aliberti S, *et al.*, Introducing a new HERMES project on respiratory infections. *Breathe* 2016; 12: 5–7.
4. Farr A, Clementsen P, Herth F, *et al*. Endobronchial ultrasound: launch of an ERS structured training programme. *Breathe* 2016; 12: 217.
5. Yousuf MI. Using experts' opinions through Delphi technique. *Pract Assess Res Eval* 2007; 12: 1–8.
6. Heiko A. Consensus measurement in Delphi studies: review and implications for future quality assurance. *Technol Forecast Soc Change* 2012; 79: 1525–1536.
7. Dajani JS, Sincoff MZ, Talley WK. Stability and agreement criteria for the termination of Delphi studies. *Technol Forecast Soc Change* 1979; 13: 83–90.