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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.

For a full list of the authors’ affiliations please see the Acknowledgements section.
| Module 1. Pathogens (respiratory microbiology) |
|---------------------------------------------|
| 1 Respiratory microbiology                  |
| 1.1 Normal bacterial flora                  | Mandatory |
| 1.2 Classification of respiratory microorganisms |
| 2 Respiratory bacteria                      |
| 2.1 Gram positive                           | Mandatory |
| 2.2 Gram negative                           |
| 2.3 Atypicals                               |
| 3 Respiratory viruses                       |
| 3.1 RNA viruses (seasonal and/or pandemic, emerging) | Mandatory |
| 3.2 DNA viruses (seasonal and/or pandemic, emerging) |
| 4 Respiratory fungi                          |
| 4.1 *Candida* spp.                          | Mandatory |
| 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                              |
| 5.1 *Mycobacterium tuberculosis*            | Mandatory |
| 5.2 Non-tuberculous mycobacteria (NTM)      |
| 6 Antimicrobial resistance                  |
| 6.1 Mechanisms of antibiotic resistance     | Mandatory |
| 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                                |

| Module 2. Host respiratory defence mechanisms against infection |
|---------------------------------------------------------------|
| 1 Natural barriers                                           |
| 1.1 Cilia/primary ciliary dyskinesia                         | Mandatory |
| 2 Innate immune systems                                      |
| 2.1 Complement                                               | Mandatory |
| 2.2 Cells                                                    |
| 2.3 Defensins                                                |
| 2.4 Cytokines                                                |
| 2.5 Inflammation process                                     |
| 3 Adaptive immune systems                                    |
| 3.1 Humoral immunity                                         | Mandatory |
| 3.2 Cellular immunity                                        |
| 4 Immune reconstitution inflammatory syndrome (IRIS)         | Optional |

*Continued*
### Module 2. Host respiratory defence mechanisms against infection (cont.)

| Topic | Compulsory |
|-------|------------|
| 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

| Topic | Compulsory |
|-------|------------|
| 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

| Topic | Compulsory |
|-------|------------|
| 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 ultrasonads and magnetic resonance imaging) | Mandatory |

### Module 5. General principles of antimicrobial therapy

| Topic | Compulsory |
|-------|------------|
| 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)
ERS syllabus for postgraduate training in respiratory infections

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. 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.

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Conflict of interest

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