CHAPTER 3
RESEARCH

More investment in biomedical research is all the more important given that we are close to breakthroughs in many areas of respiratory research, such as molecular bacteriology and virology, development of vaccines, molecular pathology and personalised medicine. The respiratory community needs to continue to advocate for a dedicated EU programme for biomedical research emphasising translational and clinical research.
The best way to tackle a problem is to fully understand it. Medical research offers us an excellent tool for understanding the causes of respiratory diseases, how they progress and what happens inside our bodies. These are the building blocks upon which new treatment strategies and cures are developed. Respiratory medical research has been shown to represent a six-fold return on investment [1]. Research into lung disease has yielded many life-changing results, such as the development of new effective asthma treatment, the increased success of lung transplants, better treatments for cystic fibrosis, and proving the link between smoking and lung cancer.

However, there are many questions that remain unanswered and many conditions that still do not have adequate treatments. Emerging research has recently shown that lung health may be determined before birth [2, 3]. Respiratory diseases often result in a progressive destruction of lung tissue that increases with age, and there are strong indications that factors influencing the unborn and newborn child may cause lung diseases later on in life [4]. One particular concern is the influence of severe infections in children on lung development. There is a great need to increase the understanding of how to prevent and treat these disorders to reduce the healthcare burden later on.

Research makes a direct contribution to the prevention and treatment of lung diseases and can also lead to dramatic increases in the quality of life for European citizens. Medical research is vital and the future national and European research programmes must reflect this to a greater extent.

Comparatively few resources have been diverted to fund research on understanding common chronic lung diseases. For example, in the UK in 2002, 13% of all deaths were due to respiratory disease; however, funding for respiratory research claimed only 2.8% of Medical Research Council expenditure [5]. More recognition and support from the European Union (EU) is needed to ensure that effective treatments and cures can be developed.

From a structural and organisational perspective, it appears that, in Europe, there are very few interdisciplinary centres of excellence in respiratory translational research. The working mode in academia is dominated by individual career planning rather than by project-oriented work. Funding support is generally short term, and international collaboration is not easy to implement. Impediments to conducting clinical trials include long bureaucratic delays, the tendency of ethical committees to be overcautious, overly restrictive confidentiality rules, unrealistic study designs, and a separation between those who look after patients and those who conduct clinical studies. It is therefore important to revive the "clinical investigator phenotype".

Research aiming at understanding mechanisms and key pathways of disease will in future improve the early detection, diagnosis and treatment of respiratory diseases. Technological advances (such as PCR) and the availability of high-throughput tools for investigating the genome, the transcriptome and the microbiome have provided opportunities to make substantial progress in mechanistic research. Preclinical and clinical biomarkers must be discovered, and their interaction with environmental factors understood, to then be validated in order, among other purposes, to refine the characterisation of phenotypes in heterogeneous diseases and to tailor the treatment to individual patients (personalised therapy). Increased understanding of epigenetic disease mechanisms could lead to disease risk stratification for targeted intervention and to targeted therapies [6].

Patient participation can be seen as a means to improve content quality, implementation and efficiency of research. Patients should be regarded as the source of knowledge on disease experiences, as they are experts in living with a chronic disease, and the consequences for quality of life.

INNOVATION STRATEGIES FOR RESPIRATORY DISEASES

Alliance for Biomedical Research in Europe to increase innovation and competitiveness

At the European level, only about 15% of funding for health-related research in EU countries comes from the EU itself [7]. That is why the European Respiratory Society is one of four founding societies, along with the European Association for the Study of Diabetes, the European Society of Cardiology and the European Cancer Organisation, of the Alliance for Biomedical Research in Europe, which aims to change the current fragmented and uncoordinated approach for biomedical research funding, by giving a single,
powerful voice to the biomedical research community across Europe. The main aim of this alliance is to maximise its impact on future research budgets, covering all health disciplines, for improved health and well-being of all European citizens.

**Collaboration between academic research and innovators**

There is a great need to find new, effective ways for collaboration between academic research and innovators, in order to develop better medicines and improved diagnostic methods.

More investment into research is all the more important given that we are close to formidable breakthroughs in many areas of respiratory diseases, such as molecular bacteriology and virology, development of vaccines and antiviral agents, boosting host defence and innate immunity, molecular pathology and personalised care for lung cancer. Moreover, breakthroughs are expected in new approaches in genetic disease, development of mechanism-based approaches for preventing lung diseases and innovative approaches for treating lung diseases and restoring pulmonary function [8]. The translation of new research findings into progress in medical practice remains a major problem [9].

Another significant problem is the real deficiency of new innovative medicines in the respiratory field, as only nine new medicines have been developed over the past 40 years. A better collaboration between industry and academic centres is desperately needed, along with new initiatives such as the Innovative Medicines Initiative (IMI), a public–private partnership with the European Commission and the European Federation of Pharmaceutical Industries and Associations (EFPIA) under the Seventh Framework Programme for Research and Technological Development (FP7) [10]. Leading investigators in respiratory medicine are involved in a number of IMI research collaborations [11], and we hope these projects will pave the way for novel and productive academic–industrial partnerships.

**EU Research: The Seventh Framework Programme 2007–2013**

FP7 bundles all research-related EU initiatives together under a common roof with four major programmes: Cooperation (collaborative research), Ideas (basic research), Marie Curie Actions (fellowship) and Capacities (research infrastructures). The budget for health research in FP7 constitutes just over 10% of the entire FP7 budget (fig. 1). The objective of health research under FP7 is to improve the health of European citizens and boost the competitiveness of health-related industries and businesses, as well as to address global health issues.

Biomedical research in Europe is facing unprecedented challenges, and funding and support for research is far below what is needed for sustained European competitiveness. New insights and therapeutic strategies are desperately needed to cope with the specific healthcare problems of the ageing population. The health theme is one of the major themes of the FP7 Cooperation programme and the EU has earmarked a total of €6.1 billion for funding this theme over the duration of FP7. Analysis of the FP7 budget shows that 4.3%, i.e. €261 million, of the budget was devoted to respiratory disease, but only 0.5% of the budget to research on asthma and chronic obstructive pulmonary disease (COPD), constituting some €30 million (fig. 2).

![Figure 1. The European Union Seventh Framework Programme for Research and Technological Development (FP7) budget (excluding EURATOM), including the allocated budget for the FP7 health theme, which forms part of the FP7 Cooperation programme.](image-url)
COPD and asthma are the diseases that, without question, pose the greatest challenge in terms of morbidity and also the direct and indirect costs to society. A more strategic investment for a dedicated and specific research strategy right across the biomedical sphere and, in particular, for respiratory diseases at EU level is desirable.

**MAJOR RESEARCH THEMES AND GAPS IN LUNG SCIENCE**

**Fields of research**

The field of lung research encompasses a wide range of common diseases, which can be broken down into five major areas: 1) the early origins of lung diseases; 2) lifestyle and lung health; 3) the lung and the environment; 4) lung defence and infections; and 5) lung diseases in an ageing population.

1) Early origins of lung diseases. The number of children who survive after a very premature birth will increase in the coming years. This will in turn lead to an increase in numbers of children with chronic lung diseases from the beginning of life [12, 13].

Prenatal factors are now known to condition lung health later in life. Nutrition deficiencies and maternal smoking have epigenetic influences on the developing lung. These epigenetic factors seem to have trans-generational effects that carry over from grandmother to mother and on to granddaughter [14–16].

The life expectancy of people affected by a range of congenital defects has increased markedly with improved care. If further progress is to be made then infants with cystic fibrosis or neuromuscular disease will require more attention with earlier intervention to improve the quality of life using new targeted biological approaches [17].

The prevention of severe early infections is also important in order to reduce the incidence of life-threatening pneumonia or bronchiolitis, which can lead to severe untreated chronic disease in adulthood, in addition to immediate severe morbidity associated with the infection itself [16, 18, 19]. There is no effective treatment for bronchiolitis, and this is a gap that must be addressed.

The future of microbiology will determine many of the advances in respiratory medicine. For instance, molecular bacteriology is being revolutionised by the next generation of sequencing methodologies, and molecular virology should follow.

Genetic and epigenetic factors related to the natural and anthropogenic environment modify defence mechanisms, leading to an excessive inflammatory response.
response to common allergens [20]. This produces allergies, in the form of rhinitis or asthma of variable severity, which often persist into adulthood.

A comprehensive knowledge of these genetic mechanisms is needed so that the available treatments can be improved [21].

2) Lifestyle and lung health. Lifestyle impacts markedly on lung health. Nutritional deficiencies impair lung growth, favour infections and decrease the ability of cells to control inflammatory processes, for example through a lack of anti-oxidative factors. A lack of physical activity combined with obesity impacts on disorders of breathing, such as asthma and COPD. Obesity leads also to obstructive sleep apnoea, which has increased in prevalence steadily over the past decade across all EU countries.

The cardiovascular and metabolic consequences of sleep apnoea are now recognised to be significant and will add to the overall burden of diseases within the EU in the next decade.

Active and passive smoking are major aetiological factors in COPD and also contribute to worsening pre-existing asthma. Asthma and COPD are the most prevalent respiratory diseases in the EU and the prevalence of both is increasing, placing a major burden on healthcare costs. There is a need to identify all participating factors in these diseases, both intrinsic and extrinsic.

The impact of social instability has become more obvious on the lung environment, and its impact on epidemics, particularly among the immigrant population, is of great concern for health in EU. Immigrant populations are those perhaps the most affected by infections such as tuberculosis.

The use of certain drugs, whether for treatment or recreation, can lead to lung injury, promoting or precipitating lung fibrosis and/or pulmonary hypertension with potentially fatal outcomes. Research should help various agencies to come to recommendations and actions on the issue of drug use and lung injury.

3) The lung and the environment. The lung is, by its nature, an organ exposed to the environment, with a surface area roughly the size of a tennis court and a separation between the blood and the air of roughly one micron, in order to allow gas exchange. The airways capture particles from nanoscale sizes up to 10 microns. This brings the lung into contact with allergens and other particulate matter; this leads to asthma in 6–10% of people of all ages, as well as to COPD in 10% of people aged over 40 years. COPD is not just the result of smoking but also reflects the effect of occupational, indoor and outdoor pollution [22–24].

New volatile organic compounds used in construction and industry have now been recognised, along with other agents, such as sulphites, chlorates, isocyanates and many other chemicals already known to be potentially toxic, as causes of chronic asthma.

Several occupations are known to lead to occupational asthma. Some jobs, such as bakers and carpenters, have a well recognised association with immunoglobulin E-mediated asthma, whereas others, such as painters, builders or hairdressers, have occupational asthma induced by mechanisms that need to be explored further if we are to develop effective prevention strategies [25].

A complementary concept that needs to be further researched is the “exposome”. The exposome can be defined as the measure of all the exposures of an individual in a lifetime and how those exposures relate to disease. An individual’s exposure begins before birth and includes insults from environmental and occupational sources. Understanding how our exposures from our environment, diet and lifestyle, etc. interact with our own unique characteristics like genetics, physiology and epigenetic makeup, resulting in disease, is how the exposome will be deciphered [26].

Carcinogens are especially abundant in tobacco smoke but are also derived from the environment. For example, radioactive radon, naturally liberated from the granite below houses, or the asbestos extracted from mines for building insulation, have been found to increase the chances of developing lung cancer. Diesel particles, mainly from traffic-related air pollution, represent another highly prevalent carcinogen that is widespread across Europe. All similar compounds need to be identified and removed from our environment, and the structures involved understood, if we are to open new avenues to a potential prevention and cure for what is now the commonest lethal cancer in Europe [27].

4) Lung defences and infections. Lower respiratory tract infections are the third most frequent cause of
death worldwide, after coronary and cerebrovascular diseases (Fig. 3). These acute respiratory infections include bacterial pneumonia and viral pneumonia, among which influenza and respiratory syncytial viral infections are included. Together, they lead to 4.25 million deaths globally each year according to the World Lung Foundation. Our ability to enhance lung defences needs to be improved, particularly by the development of more efficient and acceptable vaccines.

The lung’s defences and the occurrence of infections are tightly linked. The understanding of how infections are naturally prevented by our upper and lower airways is extremely important. In future, such knowledge will help us better understand how environment factors, such as nutritional defects, can alter these defences to allow airway infections or pneumonia [29–33].

Common cold viruses are also very important triggers of asthma in predisposed individuals. Again, the structures involved need to be understood if we are to reduce the ensuing morbidity.

The use of immune suppression in the treatment of autoimmune disorders and other diseases needs to be better individualised to prevent undue impairment of lung defences and severe secondary infections.

Early diagnosis of emerging new pathogens is crucial to allow adapted new therapies to be prescribed. New respiratory viruses have appeared and fast, reliable methods for diagnosis and typing of the viral strains should be developed in the community.

New vaccines or antiviral substances need to be developed. Multi-resistant infectious agents and emerging new fungal infections in immunocompromised patients are among the other new challenges. New antibiotics need to be developed and tested and new prevention and public health strategies developed, including for the rational use of antibiotics.

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<table>
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<tr>
<th>Disease or injury</th>
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<th>Rank</th>
<th>2030 Deaths %</th>
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<td>25</td>
<td>0.7</td>
<td>29</td>
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</table>

#: comprises severe neonatal infections and other, noninfectious causes arising in the perinatal period.

Figure 3. Leading causes of death, 2004 and 2030 compared. Reproduced with permission from the publisher [28].
Acute lung injury (ALI) and acute respiratory distress syndrome (ARDS), as well as sepsis, have a prominent role for acute critical care specialists. In fact, the mortality from ALI/ARDS and sepsis is high and has not been seen to decrease over time. It is vital that novel approaches to respiratory critical care should be considered and funded for future research in the field.

5) Lung diseases in an ageing population. Maintaining good lung health in a progressively ageing population is a major challenge for current and future physicians and will place an increasing financial burden on the economy. Ageing poses particular challenges for the respiratory system. The upper and lower airways often develop atrophy of the mucosa and impaired immune defences, resulting in more infections and cancers. Elderly patients are more likely to inhale food and liquid, while neuromuscular weakness may reduce their ability to cough effectively. Humoral and cellular immunity tend to be impaired with ageing (immunological senescence) [34–36]. All of these factors will increasingly contribute to the marked increase in lung infections with ageing, resulting in high morbidity and mortality. Physical activity, a comprehensive vaccination policy and good nutrition all help to prevent debilitating infections.

In the elderly, lung injury from inhaled particles or from infections might lead to undue scarring processes, some of which in turn lead to lung fibrosis and respiratory insufficiency. These fibrotic processes, nowadays more frequently detected, may be related to defects in the repair process and/or to an increased incidence of autoimmune diseases due to ageing. These immune processes not only lead to scarring of the distal airways but also promote vascular artery narrowing in some patients, leading to an increased incidence of pulmonary artery hypertension with age.

With ageing there is a loss of gas exchange surfaces of the lung, which might lead to reduced capacity to oxygenate blood on exercise. There is also a loss of lung elasticity, which leads to increased collapsibility of airways and the development of obstructive lung disease. COPD is now considered to be a disease of accelerated ageing of the lung, and understanding the molecular signalling pathways involved in the ageing process (cellular senescence) has identified new therapeutic targets [37]. Many of the comorbidities of COPD, such as cardiovascular disease, bone disease and diabetes, may also share these ageing pathways and future studies should investigate this [38]. Asthma is also a major problem in the elderly, and in some people may emerge as immunological and cellular senescence develops [39].

Research gaps

1) New and future investigation technologies/imaging methods. Imaging methods are improving and represent major steps in our ability to reach precise diagnoses and monitor therapies. The new techniques which are more or less already available and whose application could still be improved in future are the following:

- Real time magnetic resonance imaging for physiopathological assessments, for instance in pulmonary hypertension.
- Metabolic imaging with improved positron emission tomography, in particular in the fields of oncology and inflammatory diseases.
- Improved analysis of three-dimensional computed tomography scan applied in emphysema, fibrosis or tumour volume assessments.
- Three-dimensional echocardiographic processing for a better assessment of pulmonary hypertension and vascular anomalies, or pleural diseases.
- Functional imaging using in vivo confocal microscopy which allows the analysis of vaso-activity phenomena during hypoxia, of ischaemia reperfusion events, or of homing cells in pathologic processes, such as tumours or inflammatory diseases.
- Advances in interventional pulmonology: new tools will be important to allow intervention in the airways, in the pleural space or in the mediastinum. Important developments include the super dimension endoscope, confocal laser micro-endoscopy, optical coherence bronchoscopy and auto-fluorescence bronchoscopy.
- Development of nanotechnology for targeting in vivo inflammatory processes of tumour cells for diagnostic or therapeutic purposes.
- Development of “visiology”: combining imaging techniques with physiological measures.
- Early detection of infection, and improvement of imaging at bedside.

2) New and future diagnostic tools/biomarkers:

- Genomic diagnostics are important, and will become even more so, in the diagnosis of congenital
defects such as cystic fibrosis, neuromuscular diseases and severe rare diseases in the future. Oncological propensity will be also detected.

- Blood micro RNA for cancer diagnostics or infections, as well as rare diseases.
- Proteomics and metabolomics in breath condensate to monitor inflammatory disease before and after treatment.
- Measurement of exhaled volatile organic compounds to measure lung inflammation, and to detect specific infections and cancers.
- Deep sequencing of the genome of pathogens, to allow precise diagnosis of new pathogens or appearance of resistance to available therapies.
- Individual exposure assessments for indoor and, eventually, outdoor pollution, including irritants or carcinogenic compounds, such as radon.
- Establishment of networks, integrated surveillance systems and biobanks for rare diseases.
- Identification and definition of ARDS with an optimisation of early diagnostic approach.
- The use of non-invasive methods for the evaluation of volaemia.
- Improvement of monitoring for telemedicine approaches.
- Environment monitoring for the understanding of asthma or non-smoking causes of COPD.
- Epigenetic studies to unravel the influence of the environment on the expression of diseases, such as COPD or asthma.
- The creation of operator-independent mechanisms to non-invasively monitor lung function in the home as part of an integrated telemedicine-based management system.

3) New and future treatments/medications:

- New biological treatments using antibodies or antagonists against receptors or inflammatory enzyme inhibitors (e.g. CXCR2 antagonists, phosphodiesterase-4 inhibitors, endothelin receptor antagonists and kinase inhibitors) to suppress inflammatory pathways in diseases such as asthma, COPD, idiopathic pulmonary fibrosis, cystic fibrosis and pulmonary hypertension.
- Development of inhibitors of metabolic pathways to block oncogenes or signalling molecules in malignant processes and specific inflammatory processes, such as pulmonary artery hypertension or idiopathic pulmonary fibrosis.
- Development of novel anti-ageing drugs for treating COPD and associated comorbidities.
- Targeted and customised therapies for thoracic malignancies.
- Improvement of inhaled drug delivery systems.
- Optimisation of ventilator setting in ALI/ARDS.
- In transplantation, improved usage of borderline donor organs and of understanding for the causes and potential treatment of ischaemic reperfusion phenomena. Prevention of chronic graft dysfunction.
- Tissue engineering and biotechnology. Lung regeneration technologies may represent an alternative to transplantation in the future. Trachea transplantation on scaffold has been a first step, along with development of bio-artificial lungs.
- Basic research on cellular and molecular properties on stem cells in giving new insight on their homing, engraftment, differentiation and biological effects.
- Artificial lungs for acute respiratory insufficiency but also for end-stage lung diseases, either for the recovery of lung function or as a bridge to lung transplantation. New extracorporeal gas exchange devices are available, such as the ECMO, NOVALUNG or AVALONG.
- Development of novel endoscopic treatment strategies (i.e. endoscopic volume reduction and thermoplasty).
- Innovative approaches for treating lung diseases and restoring pulmonary function.
- International and public–private collaboration in the development of antibiotic and antiviral drugs (collaboration between government, non-governmental organisations, academic science and the pharmaceutical industry).
- International collaboration in vaccine development.
- Novel approaches to maintaining upper airway patency and promoting weight reduction in obstructive sleep apnoea.
- Increase capacity of rehabilitation programmes and self-management approaches.
RECOMMENDATIONS FOR FUTURE RESEARCH IN LUNG HEALTH

General points for the future
• Medical research is vital and the future national and European research programmes must reflect this to a greater extent in the next decade. There is a need for mechanisms for sustained rather than short-term funding.
• More translational research is needed as translation of new research findings into progress in medical practice remains a problem [8].
• There is a need to develop interdisciplinary centres of excellence in respiratory translational research.
• Strengthened training and support for clinical investigators.
• It is only with further recognition and support from the EU that effective treatments and cures will be developed.

More research collaboration needed
• There is a great need to find new, effective ways for collaboration between academic research and innovators, in order to develop better medicines and improved diagnostic methods.
• Better interaction between innovative academic centers and pharmaceutical industry is essential for new drug development.
• Public–private partnerships to stimulate new drug development such as the IMI programme are essential to move drug development forward.
• Enhanced discovery research through innovative technologies.

Early origins of lung diseases
• Increased understanding of epigenetic disease mechanisms, including natural and anthropogenic environment factors, could lead to disease risk stratification for targeted intervention and to targeted therapies.
• There is no effective treatment for bronchiolitis.
• A comprehensive knowledge of genetic mechanisms is needed so that the available treatments can be improved.

Lifestyle and lung health
• There is a need to identify all participating factors in COPD and asthma both intrinsic and extrinsic.
• Research should help various agencies to reach recommendations and actions on the issue of drug use and lung injury.

Lung and the environment
• The causes and mechanisms behind occupational asthma need to be investigated.
• The interactions between environmental and endogenous factors clearly drive health and disease, and disease treatment and prevention. The “exposome” (the concept of the individual’s exposure to environmental, social and lifestyle factors) needs to be further researched.
• Dangerous carcinogenic compounds need to be identified and removed from our environment and the complex factors causing lung cancer need further research.
• Future developments are expected in molecular pathology and personalised lung cancer care. There is a need for refined model systems and to develop biomarkers for personalised therapy.

Lung defences and infections
• For future advancements there is a need to define the respiratory microbiome in health and disease.
• Areas for future focus will be to develop mechanisms of boosting host defence and innate immunity so antivirals/antibacterials will be less required.
REFERENCES


8. Macklem PT. Con: greater funding of cell and molecular biology has not delivered what was promised to respiratory medicine. Am J Respir Crit Care Med 2004; 169: 438–439.


35. Meyer KC. The role of immunity and inflammation in lung senescence and susceptibility to infection in the elderly. *Semin Respir Crit Care Med* 2010; 31: 561–574.


