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Medical Research Education in Europe

Contents

Foreword

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Fostering and improving medical research education is crucial to biomedical research and clinical patient treatment. It has been identified as the main challenge in every biomedical research strategy report from the European Science Foundation (ESF) and European Medical Research Councils (EMRC). The EMRC White Paper, 'Present Status and Future Strategy for Medical Research in Europe' (2007), the EMRC White Paper II, 'A Stronger Biomedical Research for a Better European Future' (2011), and the ESF Forward Look strategy documents, 'Investigator-Driven Clinical Trials' (2009) and 'Implementation of Medical Research in Clinical Practice' (2011) all recommend increasing and improving education and training in the broad field of biomedicine as the most important basis for strengthening medical research and implementing the best clinical practice.

This Science Policy Briefing on Medical Research Education aims to analyse the overall situation across Europe, identify concrete challenges, and formulate practical recommendations building on existing resources or practices to help overcome the challenges identified. The recommendations include measures aimed at achieving improved recruitment and early involvement in and acknowledgement of research, improved curricula incorporating multidisciplinary skills, harmonised and high-quality common standards that enable much more mobility, better access to cutting-edge research infrastructure and resources, and more synergy among all stakeholders, from the individual to institutions and governments.

A warm thank you to Professor Giovanni Pacini, Chair of this Science Policy Briefing and to all the international experts who have contributed to this report. Finally, I would like to acknowledge and thank the EMRC staff for their work on this report.

Education is the prerequisite for biomedical research and clinical practice, and from EMRC we hope that this report will provide the tools for strengthening this important area, for the benefit of patients and societies worldwide.

Professor Liselotte Højgaard
EMRC Chair

Mr Martin Hynes
ESF Chief Executive

Introduction

Our understanding of human health and disease has been redefined in the last decades due in great part to revolutionary discoveries and innovations based on long-standing and novel healthcare challenges to both the individual patient and world populations. High-quality medical research is a cornerstone in the development of new and effective diagnostics and treatments that will lead to improved medical care and a better quality of life. For excellent healthcare provision incorporating all emerging innovations, well-educated medical researchers are an essential element.

Europe has around 440 medical schools that produce some 70,000 medical graduates every year, accounting for a total of 2.5 million medical doctors that cater to a population of 770 million people[1]. The appearance of new demographic, social, behavioural and epidemiological changes coupled with increased public expectations have revealed the mismatch between the competencies of most medical graduates and the current and future needs of the patients they mean to serve. In this regard, there is not enough emphasis on the acquisition of research skills throughout medical undergraduate and specialist training. This makes it challenging for the average medical doctor to revisit concepts around health and disease with a critical approach, challenge medical dogmas, strive to seek new knowledge, and successfully bridge the gap between the bench top and the bedside. This results in missed opportunities to transpose questions and answers from forefront research into medical practice, and to maximise the potential of translational research findings and transformative improvements for human healthcare.

The number of medical doctors who acquire adequate research training is relatively low in many European countries, particularly in primary healthcare settings compared to academic hospitals. Against a backdrop of constant redefinition of professional boundaries and skills in healthcare professions, so-called basic medical research ends up being performed in many cases by non-medical scientists such as biologists, pharmacologists, bioengineers, or biophysicists. However, these professionals generally lack the tools for bridging the gap between scientific knowledge and the issues generated in laboratories, clinics, operating theatres, and everyday conditions of human populations.

1. Frenk J, et al. Health professionals for a new century: transforming education to strengthen health systems in an interdependent world. Lancet. 2010. 4; 376(9756): 1923-58.

This context often results in a loss of cost-opportunity and a slow application of innovations that could save or improve the lives of millions of patients worldwide, and also stimulate the European economy. Efforts should therefore be made to increase the number of medical doctors exposed to cutting-edge research environments, conversant in research resources and methodologies, and capable of generating and applying new knowledge faster and of triggering innovations throughout the healthcare spectrum.

Education is an area of national sovereignty across Europe, and thus the European Union (EU) cannot oblige its Member States to standardise their education systems. In most European countries, medical research education lies at the interface between the competences of several governance institutions, namely Ministries or Departments of Education, Healthcare, Research and Innovation, or even Economy, and a series of heterogeneous regional bodies. This administrative set-up makes sense to a certain extent, because healthcare environments are by definition also educational settings, where professionals work and train in parallel. The drawback is that this complex network of stakeholders challenges efforts to expedite reforms and make anyone in particular fully accountable.

To add a layer of complexity to this setting, medical research education stakeholders are also placed among opposing forces. Firstly, the Bologna Process aims at the harmonisation of academic standards and the mutual recognition of degrees across Europe in order to increase mobility and competitiveness. In this process, medicine has been granted an exceptional status. Secondly, the increasing autonomy that universities are acquiring in some locations is leading to training schemes that are potentially even more varied. Thirdly, the novel programmes and degrees that some European medical schools are developing in other locations such as Asia or the Middle East embody new opportunities for educational experimentation and add further heterogeneity. Fourthly, there is political will within the EU to increase collaborations with neighbouring countries, and this is likely to have an impact on healthcare as well.

For all these reasons, a solid overview of good practices in medical research education would improve ongoing and future policy reforms, resulting in many benefits for Europe. There are some interesting initiatives in Europe as well as stakeholders aspiring to accelerate the process of benchmarking and harmonisation (see Tables 1 and 2).

The objectives of this ESF EMRC Science Policy Briefing on Medical Research Education in Europe are

to provide a preliminary overview of the current status of medical research education in Europe, identify good practices and the main barriers to change, and provide recommendations for improving medical research education in the future.

Current status of medical research education in Europe

Medical research education is heterogeneous in Europe. While this provides an opportunity for testing different approaches, it also poses a challenge when attempting to mutually recognise qualifications, benchmark quality standards, and increase the mobility of professionals so as to achieve a true European Research Area and European Higher Education Area. A voluntary survey conducted among several countries shows that in general terms, European countries adhere to an overall similar template (see Table 1).

Common features include PhD programmes being governed by individual universities with varying degrees of governmental or federal oversight, programme duration ranging from three to five years, doctoral candidates (or doctoral students[2]) joining PhD programmes either in the middle of their medical studies or upon final graduation, and PhD supervisors being PhD holders themselves. The requirement to publish peer-reviewed articles prior to defending a doctoral thesis is becoming increasingly popular across Europe, ranging from advisable to mandatory. Funding of candidates is one of the aspects that show the greatest local variation, with remuneration ranging from very modest grants to full salaries.

Table 1 summarises the countries studied, and Table 2 shows the main categories of stakeholders involved in medical research education in Europe.

2. For the purpose of this document, "PhD/doctoral candidate" and "PhD/doctoral student" will be considered as synonymous.

Main barriers to medical research education in Europe

A review of the key reports published in the last decade in Europe, plus direct consultations with relevant experts at national and pan-European levels, has highlighted the following challenges.

Recruitment and career development

Few medical doctors are recruited into research, and research career structures in the medical field are too heterogeneous.

Medical students with an interest in research are often identified too late, or presented with insufficient career options that encourage them to pursue training in basic medical research or clinical research. In some countries, research careers are seen as somewhat opposed to clinical careers among physicians, and research activity is not considered a significant merit to further progress in the medical career, thus discouraging scientific development in clinicians.

In addition, many European PhD and postdoctoral students travel outside Europe to science- and healthcare-hubs where research careers are better rewarded in terms of financial compensation, stability, and social prestige[1]. After acquiring the relevant skills and expertise, their return to Europe varies according to nationality, with situations ranging from a temporary brain exchange to a permanent brain drain. European countries that do not match non-European settings in terms of career progression or financial compensation fail to attract their medical graduates back, and thus fail to reap the return on investment in individuals trained mostly in European public education systems heavily subsidised by European tax payers.

Curriculum design

Medical education insufficiently incorporates research skills into its classic syllabus, and opportunities for multidisciplinarity are scarce.

The average medical doctor spends four to six years in medical school, followed by a competitive specialist training scheme lasting from three to six years. Throughout this training period, exceptionally good learning approaches in terms of methodology and content are only to be found in some European settings.

Many environments are characterised by learning approaches that seem rather conservative, with outdated classroom formats and master–apprentice relationships that do not leverage the many advantages offered by novel participatory technologies and dynamic educational approaches. In this context, the incorporation of research into the curriculum is deficient, and even highly motivated individuals find it challenging to find time to engage in such activities.

In addition, compared to standard medical practice, a research career is financially unattractive and professionally unstable. The average European medical doctor often has no dedicated time for research or access to appropriate research infrastructures.

Finally, a lack of multidisciplinarity in the curricula sometimes reduces opportunities for collaboration with other fields of knowledge with potential links to medicine, such as technology, humanities, social sciences, or economics.

Harmonisation, overarching quality control and common standards

Harmonisation and mutual recognition of degrees is still an issue in Europe, with standardised quality assurance in medical research education being largely absent, not only at the national level but also at the pan-European level.

There is no single overarching institution to ensure coherence and global quality controls. There are also no comparable standards among countries or even among schools within the same country, potentially leading to heterogeneous educational outputs.

Research infrastructures and allocation of resources

In many countries, funding of MD-PhD programmes and access to appropriate research infrastructures remains poor.

In many countries, research facilities and cutting-edge small or large research infrastructures are largely inaccessible to physician scientists in training. Information about resources and facilities at the national and pan-European level is often disperse and scant. A lack of adequate funding and institutional support further aggravates these issues.

Geographical and transdisciplinary mobility

Medical education and research training are heterogeneous within Europe, hampering mutual recognition of skills and degrees and challenging mobility and international collaborations.

A huge diversity of PhD (doctor of philosophy), DSc (doctor of science), MD (doctor of medicine), and parallel MD-PhD programmes exists within Europe. As mutual recognition of degrees is not yet automatic, it is difficult for medical doctors to move freely between countries and to pursue a pan-European research career. In addition, disparities in training standards, salaries and social security systems make the exchange of professionals between countries even more difficult.

Cooperation between universities, research organisations, healthcare centres and other public or private agents

Universities generally have poor functional connections with public or private research stakeholders, failing to maximise returns and explore new opportunities to synergise and make efficient use of people and resources.

Extramural partners often have the required state-of-the-art infrastructures, resources and expertise to add value to research programmes. Interaction between clinicians and non-hospital researchers may often be difficult due to time and human resource constraints in the clinical world and to insufficient participation of researchers from other organisations in hospital-based research.

Thus, there is a risk of not connecting the right people to work on the right ideas, of duplicating efforts, of wasting time and funds, and of failing to maximise the opportunities to improve European healthcare systems and place Europe at a sustainable pole position in key healthcare domains.

Policy recommendations for an improved medical research education in Europe

Recruitment and career development

Medical students and doctors should participate in research from the earliest stages of their training. Their output throughout all stages of their career must become acknowledged as a valuable career merit alongside others, such as teaching, clinical work or consulting in private and public work environments across Europe. A PhD should be given the same career merit as specialist training. A well-funded European Medical Scientific Training Programme would transmit best practices, foster excellence and increase collaborations and mobility across Europe.

Research careers for medical doctors may develop along diverse paths across Europe, but the milestones and outputs should be comparable. As part of their mission of rendering service to society, educational institutions should provide support for research career progression steps by offering specific training in transferable skills and subjects such as biomedical ethics and research integrity.

Career bridges should be designed to enable candidates to tailor their curriculum and to allow full comparison between merits from public or private sectors across Europe. Institutions must build and maintain active ties with collaborators outside healthcare centres so as to increase the impact that medical researchers may have in other disciplines and sectors of the economy.

Researchers should be able to remain independent when choosing research career paths that best suit their skills, preferences and opportunities, and they should also be able to develop their careers at locations that prove to be the most attractive. The design and assessment of research careers must incorporate transparency, fairness and an equal-opportunities approach, ensuring that gender, age and all other types of social diversity features are respected. European funding schemes such as the Marie Curie Initial Training Networks (FP7)[3] and Erasmus Mundus[4] should be promoted and further supported with sustainable funds, and ideally linked to similar initiatives at national and regional levels.

3. http://ec.europa.eu/research/mariecurieactions/
4. http://ec.europa.eu/education/external-relation-programmes/mundus_en.htm

Curriculum design

Undergraduate and specialist medical education programmes should incorporate (multidisciplinary) research skills and principles of evidence-based medicine as a regular part of their syllabus. Research programmes could also become more attractive by contemplating a well-tailored modular approach where candidates could sequentially complete accredited phases of shorter duration than a full-time PhD programme.

Research programmes should strive to incorporate hands-on, problem-based and systems-based approaches along with top-notch theoretical science-based training. Educational systems should develop sustainable funding models with relevant partners. This flexibility would offer more opportunities for candidates and increase the diversity in the choice of thematic modules and institutions.

Curriculum design should be ambitious and open-minded, and actively support multidisciplinarity and the practice of evidence-based medicine. In this regard, MD-PhD programmes could incorporate other disciplines (e.g. physics, mathematics, statistics, economics, ethics, social sciences and humanities, law or management) and embrace active collaborations with other healthcare professions, so that candidates could acquire tools to better formulate hypotheses, understand research observations and results, and render a better service to society.

Amidst the global explosion of information and greater accessibility to knowledge, educational institutions could consider revisiting their role and leveraging on participatory technologies and other resources and approaches to better train medical researchers for the global interdependent context in which we live. Continuous professional development programmes for senior medical researchers should also be part of this comprehensive reform.

Harmonisation, overarching quality control and common standards

In spite of the heterogeneity of schemes, Europe should aim at mutual recognition of degrees. The development of standards for the global recognition of degrees and the proactive identification of worldwide opportunities for advancement are needed. Pan-European career-tracking schemes can support the development of world-class quality standards

in medical research education. This will in turn increase the excellence and overall competitiveness of European researchers and research institutions.

The development of common evaluation tools and indicators could well be a first step towards full harmonisation, benchmarking and an overall increase in the quality and mobility of professionals and knowledge. European initiatives such as the Innovative Medicines Initiative (IMI)[5], the European Medicines Research Training Network (EMTRAIN)[6], and the Pharmaceutical Medicines Training Programme (PharmaTrain)[7] are positive steps forward. In parallel, harmonisation should also allow physicians to combine their specialist training with intensive research experience to enable them to function afterwards as more effective clinical scientists.

Independent, international evaluation panels may play a useful role in systematically assessing the output of medical research programmes and identifying areas of improvement. International research organisations could support these accountability exercises by sharing best practices for merit review or ensuring research integrity.

MD-PhD candidates and their supervisors must also play an active role in ensuring the highest quality of this process and its outcomes. Supervision must be a collective effort at doctoral schools, with clearly defined responsibilities for all stakeholders in medical research education. The role of faculty must be explicitly acknowledged and appraised, for these are the teachers, mentors and role models for future generations of MD-PhDs. Institutions must provide doctoral supervisors with professional development tools and opportunities.

Objectivity and impartiality when judging PhD curricula and PhD theses must be ensured. Evaluation criteria should be made public. Medical universities should encourage PhD jury panels to include a considerable proportion of scholars from institutions outside the home institution of the PhD candidate. PhD jury members should hold doctorates themselves. This does not preclude having a small proportion of jury members that lack such a qualification but are nevertheless well-recognised experts in a field pertinent to the PhD thesis under evaluation. PhD supervisors should also be doctors. In the case of co-supervision, at least one of the supervisors must be a PhD.

Medical universities should require that the PhD candidate publishes peer-reviewed reports (namely articles in specialised international journals), files patents, or submits other proof of original research adapted to the specificities of the medical field but in any case complying with international quality standards.

Infrastructure and allocation of resources

The number of appropriately funded MD-PhD programmes with the highest internationally accepted standards must be increased in Europe. Medical researchers should maximise the use of information technologies and attain exposure to the variety of research infrastructures across Europe, ranging from the smallest ones at their local institution, to the largest ones at the pan-European level. National and/or pan-European initiatives for cataloguing these European infrastructures as identified by the research community should be further supported by greater funding, dissemination and overarching official endorsement.

Medical researchers should comply with the highest research ethics standards and applicable regulations affecting data protection when utilising these infrastructures and making use of any human specimen collections hosted therein.

The choice of the research infrastructure to be used will remain at the discretion of the candidate, but access should be encouraged by appropriate funding and access to European research infrastructures, especially those under the IMI[5], the European Strategy Forum on Research Infrastructures (ESFRI)[8], the European Clinical Research Infrastructure Network (ECRIN)[9] and the Mapping of the European Research Infrastructure Landscape (MERIL) Project[10] frameworks. Overall funding of MD-PhD programmes needs to be improved across Europe, and new models explored wherever appropriate.

5. Innovative Medicines Initiative (IMI), a joint undertaking between the European Union and the pharmaceutical industry association (EFPIA). www.imi.europa.eu
6. European Medicines Research Training Network (EMTRAIN). www.emtrain.eu
7. Pharmaceutical Medicines Training Programme (PharmaTrain). www.pharmatrain.eu
8. http://ec.europa.eu/research/infrastructures/index_en.cfm?pg=esfri
9. http://www.ecrin.org/
10. http://www.esf.org/meril

Geographical and transdisciplinary mobility

Mobility and international collaborations at all stages of the MD-PhD career should be increased by allocating greater funds to programmes, developing standards for global recognition of degrees, and proactively identifying worldwide opportunities for advancement. Horizontal policies that help create a framework of trust among participants, such as common principles for peer review or research integrity, would yield very positive results.

Geographical and transdisciplinary mobility are a means to increase innovation and thus should be encouraged from the earlier career stages. In this regard, pan-European programmes such as Marie Curie Actions[3] and Erasmus[4] are essential to nurture this objective and should attract far greater funds.

Pan-European organisations are a useful agent when trying to establish common principles and sets of guidelines based on good practices and consensus. Recommendations contained in overarching policy documents such as those of the European University Association (EUA) or the Organisation for PhD Education in Biomedicine and Health Sciences in the European System (ORPHEUS), or specific ones such as the ESF-ALLEA European Code of Conduct for Research Integrity or the ESF European Peer Review Guide are useful starting points for the community.

Fruitful models of cooperation ranging from exchanges of faculty and students to private-public consortia around well-targeted goals, or multinational joint degrees could all benefit from smarter uses of information technologies. This would help retain talented researchers and attract non-Europeans to Europe, to contribute to the greater healthcare research enterprise.

Cooperation between universities, research organisations, healthcare centres and other public or private agents

Institutions offering medical research degrees should develop more numerous and more active connections with public and private stakeholders, be they in their immediate regional environment or worldwide.

The development of tailored win-win collaborations would optimise the use of resources and skills, motivate young and senior researchers to explore new pathways in translational research, and achieve useful results in a shorter time. Institutions should allocate funds for partnerships of this kind with players in different regions of the world, and designate highly qualified officials to actively support researchers in this endeavour.

Collaborations may include the whole spectrum of medical research education activities, ranging from educational programmes, to laboratory or field research joint projects, joint workshops, student and staff exchanges, or joint publications. Individuals from both public and private organisations could be an asset and thus should be allowed to contribute. In this regard, European initiatives such as IMI[5], EMTRAIN[6] and PharmaTrain[7] offer valuable training resources.

PhD candidates should be encouraged to link and contribute to medical innovations from the very beginning of their research career. Training on intellectual property rights and entrepreneurship should be made available as part of the doctoral curriculum, and opportunities to actively liaise with the private sector should be fostered.

Supervisors should ensure that all potential innovative aspects of the doctoral work performed are professionally managed from the beginning, with the support of dedicated staff employed by the university (at technology transfer offices or similar support services). These staff shall advocate on behalf of the best interest of the PhD candidate, the supervisor and the institution, and will advise on how best to interact with extramural collaborators that may have competing interests.

Documents signed by candidates and supervisors upon starting any doctoral research programme should include confidentiality agreements and detailed institutional policy and procedures regarding technology transfer, regardless of the final topic of the PhD thesis that each candidate may chose. Due to the strategic relevance this matter has for universities, candidates should be offered educational materials and training on technology transfer and intellectual property rights.

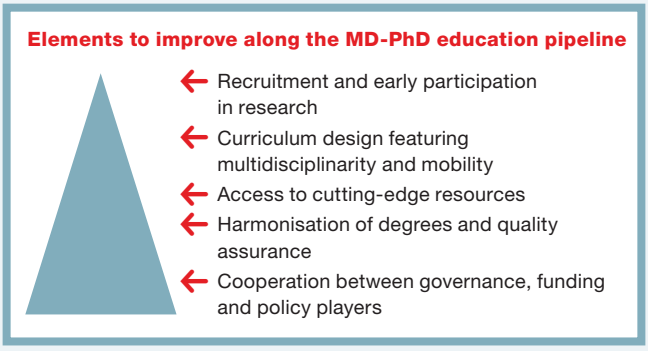

Figure 1.
Elements to improve MD-PhD education

Conclusions

Medical research education is a vital component of the modern healthcare enterprise that improves patients' lives, generates innovations through new discoveries and inventions, and activates our economy. An overview of the different models available across Europe yields a very heterogeneous picture from one country or region to another, with some challenges remaining worryingly persistent in spite of ongoing reforms.

The key challenges identified and the recommendations proposed are summarised in Table 3 and Figure 1. The main barriers revolve around a lack of comparable career progression steps; curriculum designs, educational resources and strategies that need to be modernised; healthcare systems that could be made more attractive for medical researchers; the need for new private and public funding schemes that channel sustainable support into MD-PhD programmes; and overarching institutions and common policies and practices that would ensure the highest quality so as to enable mutual recognition of degrees and facilitate more effective international collaborations.

In the face of global competition for talent and resources, and the unprecedented challenges set forth by new demographic, social and epidemiological changes, Europe must take on board all relevant stakeholders to take firm and coordinated steps in terms of programme reforms, updated governance structures, ambitious policy measures, and forward-looking resource allocations to overcome these barriers and improve medical research education for the long-term.

However, expectations need to be realistic. Medical research education is not the sole factor impacting health systems worldwide[11]. Other societal issues such as demographics, national economies, governance systems, politics and similar factors have a profound impact on the final outcome that citizens benefit from.

Additionally, as the role of physicians within healthcare systems is also evolving, their own research training needs to be fine-tuned in accordance with other professions contributing to the global picture. In this regard, efforts to train other professionals in the basics of healthcare research, and particularly its clinical aspects, could also contribute to yielding faster and greater benefits for patients.

The increasing tide towards more evidence-based policies worldwide suggests that improving research education, not only with greater funds but also with smarter curricular approaches, may contribute to shaping the doctors of tomorrow, who will be equipped with robust analytical skills and greater critical minds to challenge inherited dogmas and strive to obtain and disseminate new knowledge.

With this objective in mind, all stakeholders need to take an active and responsible role: individuals, research and educational institutions, oversight bodies, and governments. Europe has led commendable improvements in this area, but much work lies ahead. The goal of this ESF EMRC Science Policy Briefing is to constructively contribute to the ongoing debate and efforts leading to reforms in medical research education across Europe.

11. Gordon D, Karle H. The state of medical and healthcare education: A review and commentary on the Lancet Commission Report. World Medical & Health Policy, 2012. vol 4: issue 1, article 9.

Table 1: Key features of selected countries

Country	Regulatory authority/(ies) of doctoral programmes for MDs	Duration of PhD	Candidates' eligibility
AUSTRIA	• Universities regulate their own PhD programmes. • In case of Austrian Science Fund (FWF)-funded graduate programmes, all aspects are evaluated by peer review.	Three to five years.	• Candidates must normally obtain an MD prior to enrolling in PhD. Vienna has an MD-PhD programme for elite students where both run in parallel.
CROATIA	• Medical schools abide by 2004 and 2005 ORPHEUS standards ("Zagreb Declaration") and the Salzburg Principles. All have structured PhD programmes with research as the most important part.	Three years for full time PhD students, or longer, if the candidate is doing clinical work in parallel. Some PhD programmes are run jointly by medical schools and the "Rudjer Bošković" research institute.	• Candidates must have completed masters or MD degree prior to enrolment. Selection is based on previous academic records and demonstrated interest for research. • Students can take part of the courses from PhD programmes organised by other universities in Croatia or other institutions abroad. There are also extramural candidates that enrol on PhD programmes at medical schools.
CZECH REPUBLIC	• Curricula are set by universities. Some PhD programmes are run jointly by universities and research institutes.	Three to four years, with a maximum of eight years.	• Candidates join only after earning an MD or finishing masters at the university
FRANCE	• Programmes and outputs of all MD and PhD programmes are evaluated by a national independent agency (AERES).	Three to four years.	• PhD programmes can be joined either after completing second year of medical school and passing the EDI examination, or else after graduating after the sixth year. • Second year medical undergraduate students may take optional courses and an optional competitive examination to be selected for a MD+PhD course organised by the EDI Doctoral School, Inserm, and the -Liliane Bettencourt Foundation. This programme allows medical candidates to take doctoral studies either inserted after their second medical year, or else upon graduating in medicine.
GERMANY	• Universities run PhD programmes autonomously. • In case of German Research Foundation (DFG)-funded graduate programmes, all aspects are evaluated by peer review.	Usually three years.	• Depends on the details of the programme and the university. PhD candidate selection follows defined excellence criteria.
ITALY	• Public and private institutions can run their own PhD programmes upon approval of the national evaluation agency.	Three to four years.	• Candidates must have completed masters prior to enrolment. Candidates usually enrol once they graduate as MDs. If they took a specialisation course, then their PhD can last two additional years instead of three.

Supervisors' eligibility	Requirements for obtaining a PhD	Candidates funding
• Supervisors are selected by university according to their publication record, grant support and experience in student supervision.	• Publication of a thesis. • One first author publication in journal with international peer review is required.	Candidates may receive a salary, the rate of which is established by the Austrian Science Foundation. Candidates are normally employed through extramural grants.
• Supervisors must be PhD holders and must have a university position as docent (associate professor) or research degree as research associate. • Supervisors are not necessarily employed by the medical school organising the PhD programme.	• The thesis can be a monograph or compendium of several articles published in internationally recognised journals. Requirements regarding the amount of articles published, the impact factor of the journals, and the authorship position of the candidate differ across programmes. • Regardless of the form of the PhD thesis, it is mandatory to publish articles prior to the thesis defence.	Some PhD students receive a fellowship from the Croatian Ministry of Science Education and Sport, while others are sponsored by clinical or other institutions, or are self-sponsored.
• Supervisors must have a PhD degree, and fulfill minimum conditions (e.g. having authored at least three papers in relevant journals during the last three years). Supervisors can either work at university or at extramural organisations (research institute, hospital, etc.), but must always be approved by the specialisation council.	• Conditions are defined by each university. Three publications in journals with impact factor are usually required (although not mandatory), the candidate being first author in at least one of them. • Candidates are also required asked to contribute to teaching or clinical duties, depending on their home departments.	Candidates may receive stipends or salaries, but compensation varies widely.
• PhD supervisors must hold the "Habilitation à Diriger des Recherches" national diploma.	• At least one paper as first author in an international journal with significant impact factor. • Positive evaluation of the thesis work given by two scientists holding the "Habilitation à Diriger des Recherches" national diploma and external to the scientific campus of the applicant.	Students admitted to the Inserm-Liliane Bettencourt joint MD PhD programme receive funding for medical and scientific stages. The Liliane Bettencourt Fondation is the only foundation which financially supports PhDs for medical students, provided that they have been selected by the EDI.
• For DFG-funded programmes, the quality of researchers and supervisors is subject to peer review assessment.	• Requirements are defined by university. Usually at least one first-author paper in a peer-reviewed journal in addition to thesis work, and a completed research training curriculum.	In DFG-funded programmes, funding comes either through full stipends or employment positions.
• Supervisors are selected by the Doctorate Board, or are members of it, on the basis of scientific merit. • A PhD supervisor needs not hold a PhD.	• Publication of a thesis that reports the results of three years of research. • Publication of articles before dissertation is not mandatory.	Universities sponsor candidates through fellowships or even funds from joint programmes established with other institutions. Self-sponsored (voluntary) or industry-sponsored doctoral candidates are also permitted.

Country	Regulatory authority/(ies) of doctoral programmes for MDs	Duration of PhD	Candidates' eligibility
NORWAY	• The Norwegian Association for Higher Education sets the framework for PhD regulations at universities. • All PhD programmes have a mandatory course featuring introduction to medicine and research methods, and rules, regulations, and ethical aspects of medical research.	Three years (180 ECTS).	• Candidates must have completed a five-year masters degree. Medical students in the MD-PhD programme are half-way to a PhD as soon as they complete their seventh year of training (taking into account that MD training takes six years).
PORTUGAL	• Each university regulates its own PhD programmes, which must be approved by a national independent agency (A3ES).	Full-time: three to four years. Part-time: up to eight years (mostly within a restricted novel programme of internship/PhD for clinical residents or for clinicians who maintain clinical duties).	• Depends on the specific programme. In most programmes, candidates are required to be MDs, and admission to the PhD programme is based on individual merit (as assessed by CV, letters of recommendation, performance during interview, and even quality of the research proposal submitted). • There is one school offering an MD-PhD programme where undergraduate medical students are admitted to the PhD programme based on their experience in research during specific summer laboratory stages.
SPAIN	• Universities define PhD programmes in a somewhat autonomous manner, fulfilling common legal requirements but without a mandatory, nation-wide programme. Some programmes feature official label of excellence awarded by the Government.	Three to five years of research after completion of doctoral courses.	• Most MD-PhDs first graduate from medical school to later enrol on PhD programmes. Usually PhD programmes are joined in parallel to postgraduate specialist training (residency). Candidates may enrol early research education during their MD studies, but PhD can only be completed upon MD graduation.
THE NETHER-LANDS	• Standards are set by universities.	Three to four years, with unstructured training depending on topic and supervisor.	• Candidates can join doctoral programmes during their MD studies, or else upon graduation as an MD, in parallel with another occupation.
UNITED KINGDOM	• Each university regulates its own PhD degrees. The quality assurance of these regulations, and of the degrees awarded, is the responsibility of the national Quality Assurance Agency for Higher Education.	Three to four years (or longer if the candidate is doing clinical work in parallel) or for non-clinical students, who are registered part-time for their PhD.	• Any time after completion of a Bachelor degree, or equivalent. Therefore, a medical student who has completed a science Bachelor degree during the medical course may do a PhD then, returning to complete the medical degree after the PhD. Normally candidates enrol once they are at the specialty registrar level and have completed MRCP examinations or equivalent. • A few universities have combined MB-PhD degree courses, where students are admitted to a combined course similar to American MD-PhD degrees. Most medical graduates studying for a PhD degree do so after completing medical qualification, often when part-way through specialist clinical training. Prior completion of a masters degree is not required.

Supervisors' eligibility	Requirements for obtaining a PhD	Candidates funding
• Two supervisors are required per candidate. The main supervisor must hold a position at university.	Completing organised academic training (30 ECTS), independent research (PhD project) – normally published as three (between one and four) manuscripts (which are or in condition to be published in scientific journals with referee – normally first authorship in at least two of the manuscripts), PhD thesis (includes the manuscripts plus introduction and discussion), public defence and a lecture evaluated by the opponents.	• Most candidates are offered PhD research grants and are employed by the universities. Some clinical PhD students are employed by the hospital, but the PhD programme is run by the university.
• Supervisors must be PhD holders, be active researchers in the field of the PhD, and be part of a doctoral programme approved by University and A3ES national agency. Professors may also serve as supervisors for thesis work carried out at other institutions. • In the cases of doctoral grants funded by National Research Funding Agency-FCT, the quality of researchers and supervisors is subject to peer review assessment. • Joint supervision by two supervisors is frequent.	A thesis is always required. Publication of the results of the PhD research in peer-reviewed journals and first authorship prior to the award of the doctoral degree is mandatory in only some schools, but it is gradually becoming the norm. Requirements are defined by each programme/university.	• Medical doctors usually join PhD programmes in parallel with their residency training and are able to apply for additional time for research and supplementary funding from FCT-National Research Funding Agency and the Ministry of Health. • Some PhD programmes feature specific scholarships for their students. Most students maintain their clinical duties and have no complementary funding. • Funding for research is provided by the host laboratories.
• Supervisors must be PhD holders and be part of a doctoral programme approved by University. Professors may serve as intramural supervisors for thesis work carried out at other institutions.	Upon completion of doctoral courses and independent research, candidates are required to publish a doctoral thesis and defend it publicly. Requirements regarding publishing original articles prior to the doctoral dissertation vary from one institution to the other, ranging from optional to mandatory and in peer- reviewed journals with impact factor.	• Candidates are not necessarily funded, although diverse grants from public and private sources are available. National agencies offer predoctoral fellowships and post-specialist contracts to support candidates at different stages of their career. Medical doctors usually conduct PhD programmes in paralell with their residency training without supplementary funding.
• Supervisors need to hold a PhD degree. The promoter should be a professor (with an appointment at university), and the co-promoter needs to have a PhD degree.	The thesis is a compendium of three to five articles published in journals with impact factor.	• Full-time candidates can get a salary.
• Supervisors must hold a substantive or honorary university appointment, and are expected to be active researchers in the field of the PhD. • Joint supervision by two supervisors is frequent.	A thesis is always required. Publication of the results of the PhD research in peer-reviewed journals is not mandatory before the degree is awarded, but is becoming more common.	• There is a wide range of sources, from public sources (research councils and universities), to charities or private sponsors. Some PhD students are self-funded or supported by loans. PhDs taken after medical qualification, during higher (specialist) clinical training may be funded as fellowships by research councils or medical research charities, often with a salary for the PhD student equivalent to a clinical salary. Additional research training grants would cover for consumables, equipment, PhD course fees, conference travel, etc.

Table 2: Main stakeholders involved in medical research education across Europe

General stakeholders	• Universities and colleges offering MD and/or PhD degrees • Academies, learned societies and medical councils • Research institutions, research funding organisations, and research performing organisations • Hospitals, clinics and primary healthcare centres • Faculty/supervisors and undergraduate and post-graduate students • Policy makers from regional and national administrations • Industry (especially pharmaceutical and medical devices companies and healthcare publishers) • European Union bodies and agencies
Specific stakeholders	• Association for Medical Education in Europe (AMEE) www.amee.org • European Medical Research Training Network (EMTRAIN) www.emtrain.eu • European Council of Doctoral Candidates and Junior Researchers (EURODOC) www.eurodoc.net • Organisation for PhD Education in Biomedicine and Health Sciences in the European System (ORPHEUS) www.orpheus-med.org • European University Association (EUA) www.eua.be • League of European Research Universities (LERU) www.leru.org • European Association of Institutions in Higher Education (EURASHE) www.eurashe.eu • European Federation of National Academies of Sciences and Humanities (ALLEA) www.allea.org • Federation of European Academies of Medicine (FEAM) www.feam-site.eu

Table 3: Summary of main challenges and recommendations to help overcome them

Topic	Challenge	Recommendation
Recruitment and career development	Few medical doctors are recruited into research, and research career structures in the medical field are too heterogeneous.	• Medical students and doctors should participate in research from the earliest stages of their training. Their output throughout all stages of their career must become acknowledged as a valuable career merit alongside others such as teaching, clinical work or consulting in private and public work environments across Europe. A PhD should be given the same career merit as specialist training. • A well-funded European Medical Scientific Training Programme would transmit best practices, foster excellence and increase collaborations and mobility across Europe.
Curriculum design	Medical education insufficiently incorporates research skills into its classic syllabus, and opportunities for multidisciplinarity are scant.	• Undergraduate and specialist medical education programmes should incorporate (multidisciplinary) research skills and principles of evidence-based medicine as a regular part of their syllabus. • Research programmes could also become more attractive by contemplating a well-tailored modular approach where candidates could sequentially complete accredited phases of shorter duration than a full-time PhD programme.
Harmonisation, overarching quality control and common standards	Harmonisation and mutual recognition of degrees is an ongoing issue in Europe, with standardised quality assurance in medical research education being mostly absent not only at the national level but also at the Pan-European level.	• In spite of heterogeneity of schemes, Europe should aim at mutual recognition of degrees. The development of standards for the global recognition of degrees and the proactive identification of worldwide opportunities for advancement are necessary. • Pan-European career-tracking schemes can support the development of world-class quality standards in medical research education. This will in turn increase the excellence and overall competitiveness of European researchers and research institutions.
Research infrastructures and allocation of resources	In many countries, funding of MD-PhD programmes and access to appropriate research infrastructures remains poor.	• The number of appropriately funded MD-PhD programmes with the highest internationally accepted standards must be increased in Europe. Medical researchers should maximise the use of information technologies and attain exposure to the variety of research infrastructures across Europe, ranging from the smallest ones at their local institution, to the largest ones at the Pan-European level. • National and/or pan-European initiatives for cataloguing these European infrastructures as identified by the research community should be further supported by greater funding, dissemination and overarching official endorsement.
Geographical and transdisciplinary mobility	Medical education and research training are heterogeneous within Europe, hampering mutual recognition of skills and degrees and challenging mobility and international collaborations.	• Mobility and international collaborations at all stages of the MD-PhD career should be increased by allocating greater funds to programmes, developing standards for global recognition of degrees, and proactively identifying worldwide opportunities for advancement. • Horizontal policies that help create a framework of trust among participants, such as common principles for peer review or research integrity, would yield very positive results.
Cooperation between univer–sities, research organisations, healthcare centres and other public or private agents	Universities have generally poor functional connections with public or private research stakeholders, failing to maximise returns and explore new opportunities to synergise and make efficient use of people and resources.	• Institutions offering medical research degrees should develop more numerous and more active connections with public and private stakeholders, be they in their immediate regional environment or worldwide.

Annex 1. Case studies

A small number of European and non-European countries that voluntarily provided information about their MD-PhD educational systems were studied in further detail to illustrate the variety of approaches that exist. The participating countries were the United Kingdom, Denmark, Finland, Iceland, Norway, Sweden, Estonia, Poland, Czech Republic, Slovakia, Hungary, Croatia, France and Australia.

United Kingdom

Until about 1970, it was rare for a British medical graduate to study for a PhD degree. Since then, it has become more common, and it would now be unusual for an individual to be appointed to an academic position in a university medical school without a PhD. Also, there are clinicians in hospital appointments who have a PhD degree in addition to their basic medical qualification and clinical specialist qualifications, and clinicians of this type often remain active in research.

The qualifying medical degree in British universities is normally a bachelor of medicine and surgery, abbreviated in many different ways – MB BS, MB BChir, BM BS, and so on. Most universities allow students to take an extra year during the medical course to complete a bachelor degree in a relevant subject, such as biochemistry, molecular biology, pharmacology, medical ethics, etc. This is called an intercalated degree. The MD degree – doctor of medicine – is a research degree, normally with requirements very similar to those of a PhD degree.

The PhD degree can be taken at any time after the student has completed a bachelor degree or equivalent: the student may take extra time during the undergraduate medical course to complete a PhD degree as well as the qualifying MB degree; a PhD degree can be done immediately after medical qualification; or a medical graduate can take time out of his or her postgraduate specialist medical education to study for a PhD degree.

The PhD degree may also be an advantage when applying for high-level clinical positions. There have been few studies of the outcome of PhD training for medical graduates. However, the Wellcome Trust examined the later careers of all PhD students funded through its Medical Graduate Fellowship scheme (which supports PhD studies during postgraduate specialist training) and found that almost all former Medical Graduate Fellows had highly successful clinical academic careers.

Nordic countries (Denmark, Finland, Iceland, Norway and Sweden)

Nordic countries share strong historical, cultural and linguistic ties, which reflect on the flexible approach they have in place when it comes to collaborating in research, participating in each other's doctoral juries and evaluation panels, and mutually recognising PhD qualifications. In general, Nordic countries favour a combined MD PhD training approach. A PhD is composed of an initial theoretical part (accredited courses or similar), followed by an experimental phase where the PhD candidate performs original research under supervision and often publishes the results as scientific papers for obtaining the doctoral degree.

Candidates are mostly funded by national research councils, universities or private organisations. In the specific case of medical doctors, they may also be employed by hospital departments. Less frequently, candidates are also allowed to join PhD programmes bringing in their own funds. In countries such as Sweden, Norway and Denmark, a PhD is regarded as an additional merit for MDs aiming at high-level positions at academic hospitals.

In spite of overarching similarities, some differences persist. One of these is the length of the programmes. Sweden and Finland have four-year programmes, while Denmark, Norway and Iceland have three-year programmes. Expectations regarding the relative weight of the research component and output measurement are also different. A joint committee to start work in autumn 2012 has been established to harmonise these aspects.

Central and Eastern European countries (Estonia, Poland, Czech Republic, Slovakia, Hungary and Croatia)

Different countries take different approaches to exposing medical students to research.

In general, doctoral programmes across Central and Eastern Europe last three to four years, with some exceptions (e.g. in Estonia four years for internal study, and five years for external study). In the Czech Republic, the maximum duration of external PhD study is eight years, and if the dissertation is not successfully defended within this period, the programme is terminated.

In most countries, MD-PhD candidates can only be admitted to a PhD programme upon obtaining an MD degree. The exception is Hungary, where students still at the end of their MD studies are allowed to enrol in a PhD programme.

In most countries the framework of PhD education is defined by the different national governments, but indi-

vidual universities have autonomy to design particular features of their PhD programmes and decide on official criteria for awarding PhD degrees.

In some countries, for example Slovakia, research institutes such as the Academy of Sciences are allowed to conduct independent doctoral programmes, while in others, such as the Czech Republic or Croatia, programmes must be run jointly with a university. In Estonia, there are Doctoral Schools formed between the country's six public universities and external partners. Doctoral Schools are project-based and are partially sponsored by the European Social Fund. Their aim is to increase interdisciplinarity and international and national cooperation, and improve the quality of tutoring, and for this they offer training in transferable skills. Candidates are allowed to train as medical specialists and enrol in doctoral programmes in parallel.

Once admitted, PhD students must take overarching methodological and theoretical courses in a wide variety of subjects. Generally, proficiency in English (or other European languages such as French, German or Spanish) is required.

Criteria for successfully completing PhD studies vary among countries and even among universities within a country, and are normally defined by the latter. Policies regarding salaries for PhD students vary widely. In some countries PhD students receive stipends from the government, while in others proper salaries exist. In either case, financial compensation for PhD candidates is very low.

In most countries there is a global trend towards increasing the quality of the PhD by strengthening the requirements regarding the number and quality of publications needed prior to defending the PhD thesis, and by improving the social and financial conditions of the candidates. In many countries such as Slovakia, current discussions focus on attaining world-class standards by embracing the Standards for PhD Education in Biomedicine and Health Sciences in Europe according to ORPHEUS-AMS-WFME criteria.

France

Since 2003, Inserm and the Liliane Bettencourt Foundation (LBF) have offered a coordinated fellowship to financially support students selected to follow a double MD-PhD course (double cursus). Each year, some 150 students in their second year of medicine take a national exam and the top 20 to 25 are selected for this course. The students receive 470€ a month during the 16 months of their master's studies and 1,700€ a month during the 3 years of their PhD from the LBF. They are further supported by a monthly salary of 1,700€ from Inserm during the 3 years of their second clinical cycle. Their internship is supported by hospital grants, while their residency is supported by hospital grants and university funds.

The experience accumulated by the Inserm-LBF School since the course was launched 9 years ago clearly indicates that the best and easiest system is to complete the M1/M2 –PhD segment as early as possible. Today, 129 students are enrolled in this double MD-PhD course, at the end of which they will have completed a full MD degree in addition to a full master's and scientific PhD degree.

In addition, students benefit from individual tutoring with the staff of Inserm-LBF. They also receive complementary training in fundamental biology and medicine throughout the double cursus during dedicated weeks where they attend lectures and conferences. The LBF also provides fellowships for those who wish to complete a post-doctoral year and offers support to students who have obtained their PhD to attend several international congresses.

Finally, the Inserm-LBF School recruits some students for a similar double Pharmacy-PhD course.

Australia

There is concern in Australia that few medical graduates are making a commitment to research as a significant part of their careers. Medical specialisation is controlled entirely by colleges, such as the Royal Australasian College of Physicians and the Royal Australasian College of Surgeons. Colleges and hospitals have emphasised clinical training programmes over research work programmes leading to a doctorate.

There is no nationwide coordination of a programme for doctoral research. The largest and most established universities have academic departments in major hospitals and provide support for a research higher degree programme at these sites. There is currently little coursework in most PhD programmes.

Doctoral programmes generally recruit medical graduates after completion of their postgraduate clinical training programmes. Very few PhD programmes are actually combined with medical degrees from the onset. An estimated two thirds of the small proportion of medical graduates who undertake research training enrol for a PhD.

An estimated one third of medical graduates training in research enrol for a two- to three-year research programme, usually with a clinical focus, leading to the award of a Doctor of Medicine or MD.

PhD supervisors must have an appropriate research record and be endorsed by a specific university. Interestingly, many universities have training programmes for supervisors.

The outcome of both the PhD and MD by research is a major thesis, which is examined externally but not defended publicly. Some medical schools have offered an MBBS/PhD programme. Most medical graduates who choose to complete a research training programme and obtain a research degree at doctoral level do so after their specialist training programme and are generally supported by a tax-free scholarship, which they supplement by undertaking some clinical work.

The solution to these current challenges in attracting medical graduates to undertake research higher degrees at doctoral level would involve support from the specialty colleges for research training to integrate this better with clinical training, acceptance by government (which funds most of the clinical training positions) that funding should be provided at a comparable level for those who spend time training in research, more substantial research training and experience during the medical course, and better coordination of a research training programme for clinicians across different universities.

Annex 2. Bibliography

ESF EMRC White Paper 'Present Status and Future Strategy for Medical Research in Europe'. November 2007.

ESF EMRC Forward Look 'Implementation of Medical Research in Clinical Practice'. May 2011. ISBN 978-2-918428-36-7.

ESF EMRC White Paper II 'A Stronger Biomedical Research for a Better European Future'. September 2011. ISBN 978-2-918428-35-0.

OECD Global Science Forum. 'Facilitating International Cooperation in Non-Commercial Clinical Trials'. October 2011.

League of European Research Universities (LERU). 'Harvesting talent: strengthening research careers in Europe'. January 2010.

European University Association (EUA). 'Doctoral Programmes in Europe's Universities: Achievements and Challenges'. 2007.

Organisation of PhD Education in Biomedicine and Health Sciences in the European System (ORPHEUS), Association of Medical Schools in Europe (AMSE) and World Federation for Medical Education (WFME). 'Standards for PhD Education on Biomedicine and Health Sciences in Europe'. 2012. ISBN: 978 87 7934 600 0.

Organisation of PhD Education in Biomedicine and Health Sciences in the European System (ORPHEUS), 'Towards Standards for PhD Education in Biomedicine and Health Sciences', 2009.

European University Association (EUA)-Council for Doctoral Education, Salzburg Principles and Salzburg II Recommendations. Europe 2020 Flagship Initiative Innovation Union.

League of European Research Universities (LERU). 'Doctoral degrees beyond 2010: training talented researchers for society'. March 2010.

Banff Principles on Graduate Education, agreed by the US Council of Graduate Schools, the EUA, the Canadian Association for Graduate Studies, the Australian Deans and Directors of Graduate Studies, and the Association of Chinese Graduate Schools. 2007.

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