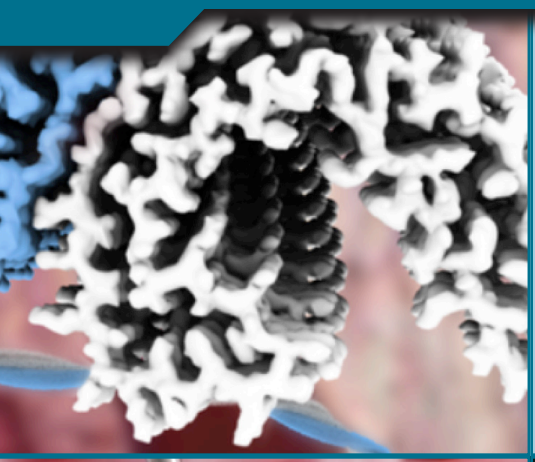
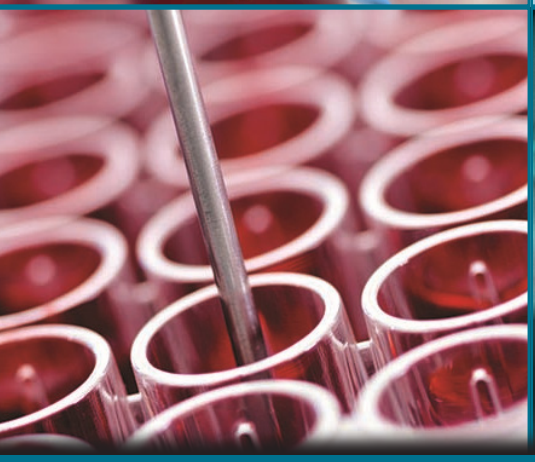
MRC Medical Research Council

Impact Report 2017





ISBN 978-0-903730-26-6

When providing a citation for this document we recommend the following:

Medical Research Council (2018) Impact Report 2017.
Publisher: Medical Research Council, Swindon, UK. ISBN: 978-0-903730-26-6

Any enquiries related to this publication should be sent to us at:

Medical Research Council, Polaris House, North Star Avenue, Swindon, SN2 1FL or
corporate@headoffice.mrc.ac.uk

This publication is available at http://www.mrc.ac.uk/publications/browse/impact-report/

Table of Contents

Introduction 4

Priority Challenges 5

Discovery for medicine 15

Transforming health research and innovation 20

Developing talent and skills 29

Celebrating science 31

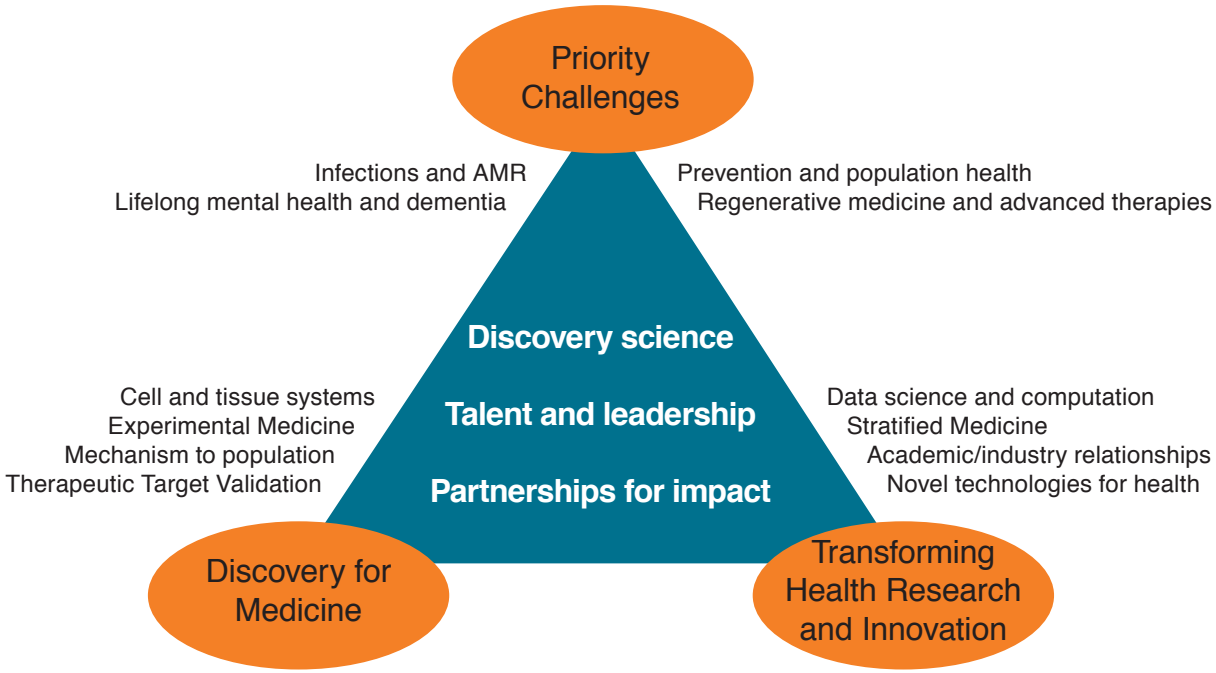
Annexes 32

Introduction

For more than 100 years, the MRC has provided funding and support that has led to some of the most important developments in modern medicine; from the development of penicillin, the first high-resolution structures of proteins and DNA and the discovery of interferon through to the development of the randomised controlled trial, inventions of MRI, monoclonal antibodies, DNA sequencing and pioneering work in stem cells and anti-microbial resistance.

The MRC Strategic Plan, *Research Changes Lives*, emphasises the impact that world-class research has on improving the health and wellbeing of society. The plan highlights the role that research has in delivering better health and wellbeing through developing new treatments for diseases, refining research infrastructures, maintaining excellent capability in discovery science and integrating strong industry collaborations and technological advances to facilitate translation.

The *Impact Report 2017* includes examples of activity that has delivered health gains, provided robust evidence for new policies and realised economic impacts, as well as increased understanding about the mechanisms of resilience, repair and replacement, and disease prevention and treatment. Publications of MRC-funded research continue to show impact on knowledge by being cited ahead of the rest of the UK and other comparator nations at twice the world average. The MRC continues to support research that secures measurable impacts that improve public health and UK wealth.



Priority Challenges

Introduction

The MRC provides a range of funding mechanisms tailored to support research across the biomedical spectrum. In collaboration with the leading UK and global health organisations, the MRC has made resources available for key areas of research that provide not only the best potential for scientific advancement but also the greatest long-term improvements to societal health.

The MRC's research focus on priority challenges for health research – infections, lifelong brain health, prevention, and regenerative medicine – is poised to deliver substantive progress in tackling health challenges facing the UK and the world.

Prevention and population health

Daily pill to prevent HIV infection: the PROUD Study

The ground-breaking results from the PROUD study, published in 2016 by the MRC Clinical Trials Unit, indicated that a treatment known as PrEP is highly protective for a high-risk group of people, reducing the risk of HIV infection by 86%. This protection is estimated to be able to save the NHS around £1 billion over an 80-year period.

PrEP is a type of infection control known as pre-exposure prophylaxis, which is the provision of antiretroviral drugs before HIV exposure to prevent infection. This prevention strategy targets people who are HIV-negative but at high risk of infection. Launched in 2012, the PROUD study looked at whether offering daily HIV PrEP to men who have sex with men was a reliable way to prevent them from becoming infected if exposed to the virus. This study was led by the MRC Clinical Trials Unit at University College London and Public Health England, in partnership with the pharmaceutical company Gilead (which manufactures the PrEP drug Truvada).

The MRC Proud Study looked at whether daily treatment with PrEP (blue pills on the right) could prevent HIV transmission in uninfected populations. Image credit: Jeffrey Beall (Creative Commons)

The trial leader **Professor Sheena McCormack** and the rest of the team working with the NHS and local authorities have made PrEP available to all patients in Scotland and trialled to 10,000 patients in England for cost-effectiveness. Based on data from the trials, a 2017 Lancet paper has estimated that PrEP would save the NHS more than £1 billion over an 80-year period (£12.5 million per annum).

PrEP was already known to reduce the incidence of HIV infection in placebo-controlled trials. The PROUD study was designed to see if the same effect would be found in a real-world situation where participants knew they were taking an active drug. It aimed to address outstanding questions such as whether taking PrEP would change sexual risk behaviour – for example increasing the number of partners they did not use condoms with and increasing the rate of other sexually transmitted infections (STIs) – and whether or not it would be cost-effective to make it available on the NHS.

Prevention strategies targeting obesity are helping change government policy

Effective interventions for weight loss can now be embedded in routine clinical practice thanks to results from MRC-funded research. The researchers have shown that a GP intervention aimed at people who were overweight led to 40% taking meaningful action to lose weight. Their results showed that commercial weight loss programmes were effective among people motivated to seek help to lose weight.

Professors Paul Aveyard and **Susan Jebb** at the **University of Oxford** have developed an inter-disciplinary collaboration to develop and test various interventions to help people lose weight. The focus of their research is to find effective wide scale interventions to deliver clinical and public health benefits.

In 2016, they published the results of a clinical trial, showing that a 30-second opportunistic intervention by GPs to people who were overweight and consulting about another problem was well-received and led to 40% taking meaningful action to lose weight. In this trial, the action concerned was taking up a 12-week NHS-supported referral to a commercial weight management provider. At the end of a year, the people who were offered a referral had lost 1.4kg more than the group who had been advised to lose weight but not offered support. The results showed that these commercial weight loss programmes were effective among people motivated to seek help to lose weight, indicating ways in which these interventions can be embedded in routine clinical practice.

One in four adults in the UK are now obese, significantly increasing the likelihood of developing many chronic diseases such as heart disease, type 2 diabetes, and certain types of cancers. Importantly, weight loss has been shown to improve health outcomes. Tackling obesity and thereby preventing the development of these chronic diseases is therefore a government-wide priority in the UK.

Infographic on Professors Aveyard and Jebb's clinical trial on weight loss interventions, used with permission.

Professors Aveyard and Jebb are actively involved in helping translate their research into policy and results from their research have helped shape local and national government policy related to the commissioning of weight management services. For example, Professor Jebb is drawing on her experience in the conduct of weight management trials to provide input to the NHS Diabetes Prevention Programme as a member of the NHS Expert Reference Group. Started in 2016, over 26,000 people have already been referred to the programme from almost half of the Clinical Commissioning Groups (CCGs) in England. The programme will gradually roll out to the whole country by 2020 with an expected 100,000 referrals to diabetes prevention programmes comprising diet, activity and weight management interventions. The research has demonstrated that this will be an effective way to address the human and societal cost of diabetes.

> *"Obesity increases the risk of developing diabetes, heart disease, and many different types of cancer. Losing weight can therefore be one of the most effective ways to prevent these diseases from occurring. Our research helps identify practical interventions that clinicians can offer in their everyday practice to motivate and support people to lose weight.* – **Professor Paul Aveyard** at the **University of Oxford**

Diet study shows that Mediterranean diet could prevent 19,000 deaths a year in UK

In 2016, MRC-funded scientists studying the UK's eating habits showed that thousands of deaths from heart disease and stroke could be prevented if everybody ate a Mediterranean diet. The health benefits of the Mediterranean diet – rich in olive oil, fruits, and vegetables – have been previously demonstrated specifically for heart patients, but this study, using the EPIC-Norfolk cohort, is the first to demonstrate the beneficial effects in practice on the wider UK population.

Professor Kay-Tee Khaw at the **University of Cambridge** and **Professor Nick Wareham** at the **MRC Epidemiology Unit** analysed data from the European Prospective Investigation into Cancer and Nutrition (EPIC) cohort in Norfolk (EPIC-Norfolk). Gathering data about eating habits among nearly 24,000 people in Norfolk over an average of 12 to 17 years, the research team found that 12.5% of heart attack and stroke deaths that occurred could have been prevented. In the context of the UK population, this would be 19,000 deaths averted out of the 155,000 that occur as a result of heart disease every year. This result demonstrated that the Mediterranean-style diet was effective at averting heart attacks in a real-world population. This confirms and extends a similar result seen in a previous study on people at risk of heart disease.

The UK NICE guidelines recommend a Mediterranean based diet for people already diagnosed with cardiovascular disease, to prevent further cardiovascular episodes such as heart attack and stroke. However, until now the association of the Mediterranean diet with preventing the disease occurring in the first instance has not been examined in the UK. This important study by Professor Khaw and the EPIC-Norfolk team highlights that a Mediterranean diet can indeed help prevent heart disease.

The Mediterranean diet is rich in fruit and vegetables, olive oil, nuts, legumes, with moderate amounts of some fish and dairy, and very little red and processed meat. Image credit: Public Domain

The EPIC study, of which EPIC-Norfolk is a subset, is one of the largest cohort studies in the world, with more than half a million (521,000) participants recruited across 10 European countries and followed for almost 15 years. EPIC is co-ordinated by the World Health Organisation, supported by the European Union and national funding agencies. Large scale, extremely long-term, carefully designed and maintained cohorts are a valuable resource for researchers who can concentrate on developing ways to analyse these datasets to answer pressing public health questions, in the case of EPIC about the impact of changing diet and lifestyles on health. The MRC has supported UK contributions to EPIC since its inception and ensured its relevance to the UK population as well as questions of global importance. MRC-funded researchers have made substantial contributions to the development of the cohort and the many studies that have used the dataset.

Continuing investments in societal wellbeing

UK Prevention Research Partnership

To continue the fight against non-communicable diseases, the launch of UK Prevention Research Partnership (UKPRP), in March 2017, is guided by lessons learned from MRC-led National Prevention Research Initiative (NPRI). The UKPRP brings together research councils, charities and UK health departments to support a new multidisciplinary initiative.

The MRC has long supported prevention research and was a key partner in NPRI from 2005 to 2011. The evaluation of the initiative provided encouragement that the UKPRP could be transformative for UK prevention research. The NPRI committed a total of £34 million to 74 primary prevention research projects aimed at reducing the burden of chronic disease.

> *"Funding through the NPRI scheme for our research has been invaluable, and we are really encouraged to see the impact this is having on policy and practice"* – **Professor Paul Aveyard** at the **University of Oxford** is a co-investigator on an NPRI project.

The NPRI made a significant impact on the UK funding landscape for prevention-related research. However, the review of NPRI highlighted several improvements that could result in greater impact. These are: 1) subsequent funding focussed more on putting new interventions into practice, 2) a greater focus on developing interventions that act at a level beyond the individual (for example at group, community or population level to address societal health), 3) included more work on the cost effectiveness of prevention strategies, and 4) modelling the likely long-term impact on disease outcomes. These recommendations were echoed in the recent "Improving the Health of the Public by 2040" report from the Academy of Medical Sciences which has funded by the MRC and Wellcome Trust.

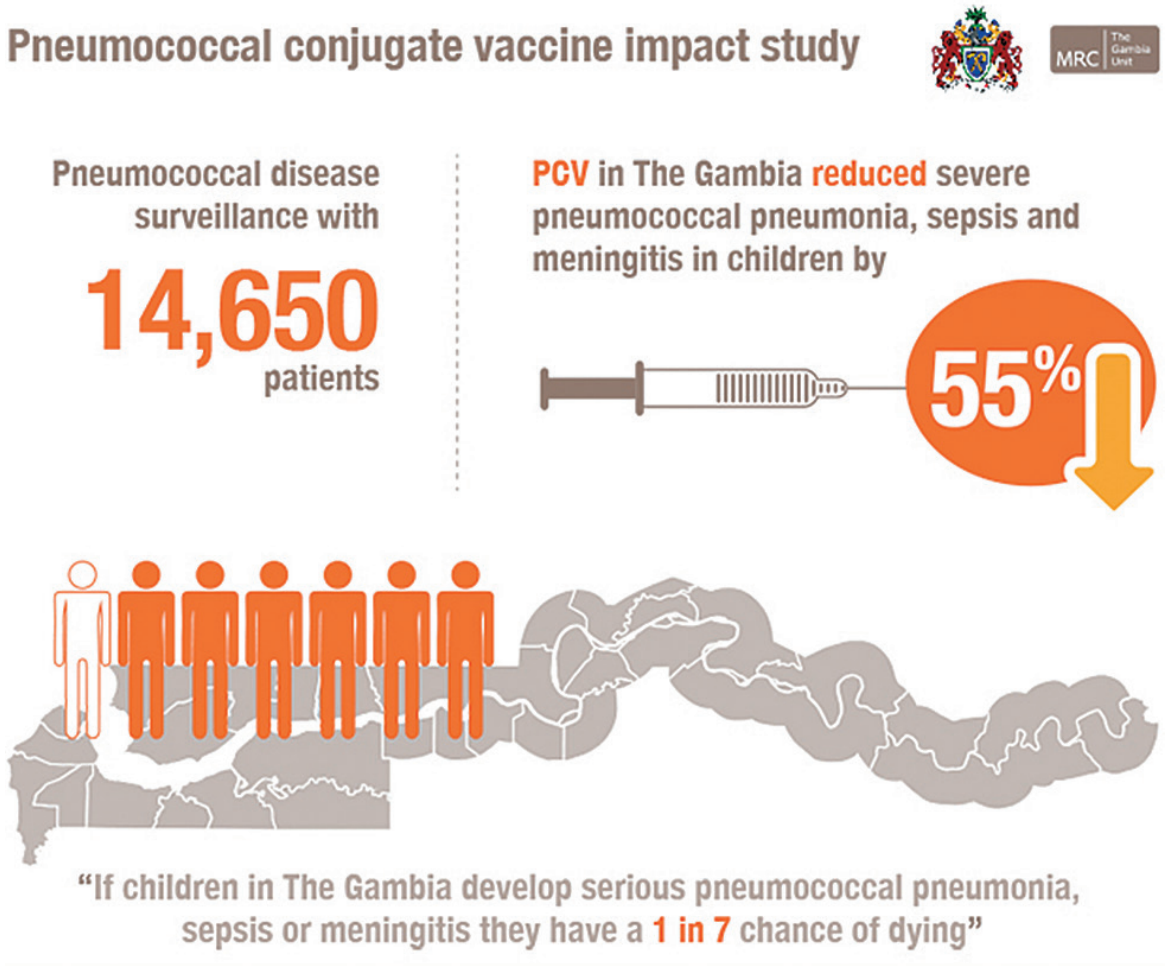
The UKPRP aims to approach these concerns by taking a highly multidisciplinary, whole system approach to prevention, including policy, legal, service, individual, group, cultural, environmental and commercial. This includes working to implement current research innovations with users, the public and decision-makers responsively – while continuing long-term research in prevention.

Addressing global infections

Preventing infections: a new pneumococcal vaccine is expected to save thousands of lives across Africa

In April 2016, the European Medicines Agency approved a new multi-dose preparation of pneumococcal vaccine Prevenar 13®, sponsored by biopharmaceutical company Pfizer, based on an MRC study. The roll out of this vaccine is expected to save the lives of 160,000 children per year. A national trial led by the MRC Unit The Gambia in 2014 had demonstrated the vaccine to be effective, safe and tolerable for children between two and four months of age. The new vaccine was more cost-effective and efficient than the single-dose preparation and is being distributed in many countries as part of the WHO Expanded Programme for Immunisation.

Since the 1980s, the MRC has supported research on *Pneumococcus* bacteria, which is responsible for around one million deaths each year among children in developing countries. Spearheaded by the MRC Unit The Gambia, clinical trials in the 1990s-2000s showed the vaccine (PCV) was 77% effective at preventing infection, resulting in a 16% reduction in the number of deaths and 37% reduction in cases of pneumonia. Introduction of PCV has led to 49 million children fully immunized and averted an estimated 230,000 to 290,000 deaths of children under five years old. This vaccine not only saves lives but also reduces a substantial economic burden on the health system and families. Prevenar13® also provides significant logistical and economic benefits, including a 75% reduction in temperature-controlled supply chain requirements, United Nations International Children's Education Fund (UNICEF) shipping costs and storage requirements at the national, regional, district and community levels.



Establishing tools to address emerging global epidemics

MRC research, facing the Zika outbreak in 2016, has shown coordination of the necessary tools to tackle future epidemics: from sequencing viral genomes to establishing accurate models for predicting the spread of infections. Here we highlight how MRC initiatives, university units and centres, and MRC-funded technologies have come together to address the global Zika threat.

Emerging epidemics, such as the mosquito-borne virus Zika, demonstrate the necessity of rapid coordinated responses from research funders such as the MRC to allocate funding to this global research challenge within a very short time frame. The agility and capacity provided by this funding enables researchers to develop critical insights into the nature of the virus and/or potential avenues for its management or prevention, and serve as a model for how we can successfully tackle the health risks posed by emerging infections such as the Zika virus.

In 2014, it was suggested that the Zika virus was linked to brain damage in thousands of babies in Brazil. In response to the Zika epidemic, in early 2015 the MRC provided funding to both understand and combat this emerging outbreak. In February 2016, the MRC announced a £1 million funding call as part of a rapid response initiative. This was followed by further support from Wellcome Trust and Newton Fund to a total of £3.2 million in March 2016. In parallel, the MRC joined global funders, institutions, NGOs and academic journals in a commitment to sharing data and results relevant to the current Zika crisis and future public health emergencies as rapidly and openly as possible.

By October 2016, researchers led by the **MRC-University of Glasgow Centre for Virus Research** (CVR) had successfully sequenced the full length Zika genome from a Brazilian patient. The new CVR facility was established in 2015 with a £10 million commitment from the University of Glasgow and the MRC. The CVR represents the UK's largest grouping of human and veterinary virologists with vital contributions to international research initiatives. Professor Alain Kohl at the CVR is a founding member of ZIKAlliance, a multinational and multi-disciplinary research consortium comprising 53 partners worldwide. With the support of Horizon 2020, the ZIKAlliance project will investigate clinical, fundamental, environmental and social aspects of Zika virus infection.

A mosquito obtaining a bloodmeal from a human host. Image credit: CDC/ Dr. William Collins, Public Domain

To respond effectively to emerging global epidemics requires a level of prediction, modelling the likely spread of an infection. **Dr Neil Ferguson** from the **MRC Centre for Outbreak Analysis and Modelling at Imperial College London** has provided recommendations for policy makers based on modelling of the Zika epidemic. In 2016, the World Health Organization was concerned that the Zika epidemic was likely to spread to all countries in the Americas except for Canada and Chile. Dr Ferguson's research published in July 2016 accurately predicted an end to the current epidemic within three years, with the herd immunity developing within the population delaying further large-scale epidemics. Current trends show significant reductions in transmission from 2016 to 2017; from the 205,578 cases to just 13,253 in Brazil and the 224 non-travel related cases in the US to just one. Accurate modeling of the progress and prevalence of infection is important because it impacts on preparations for a future large-scale resurgence of the epidemic and planning interventions, such as the current clinical trials of vaccines. As the infected population becomes smaller the trial population must be focused on the people with the virulent form of the virus. This requires an accurate and rapid identification of Zika virus in each individual in a trial. For Zika cutting-edge point-of-collection sequencing technology, the Oxford Nanopore MiNION sequencer, has been utilised in field studies with excellent results. Oxford Nanopore Technologies, a spinout from MRC funded research in 2005, have donated MiNION reagents to help Zika researchers working in South America. The results published in May 2017 showed how the compact MiNION sequencers were ideally suited to the task, allowing researchers travelling thousands of miles across remote regions in Brazil to sequence Zika virus directly from clinical samples on the road.

> *"MRC support for our Zika virus project with colleagues in Brazil allowed us to start work on this important human pathogen quickly. From there we have developed other collaborations and projects that we wouldn't have been able to develop without the early support from MRC"* – **Professor Alain Kohl, MRC-University of Glasgow Centre for Virus Research**

Continuing investment in emerging areas of research

Health Data Research UK

Building on more than £100 million in funding from the MRC since 2012, the Health Data Research UK (HDR UK) is a multi-funder interdisciplinary institute for health and biomedical informatics research. The MRC is leading on the establishment of the HDR UK with the aim of capitalising on the UK's strengths in health data.

The MRC also funded the development of eMedLab, a high-performance cloud-computing platform with a focus on three disease areas. In March 2017, eMedLab was awarded the Best Public Sector Project at the annual UK Cloud Awards. Created in 2015, this platform is proving invaluable to researchers studying cancer, heart disease, and rare diseases. eMedLab allows scientists to analyse human genome data and data-rich medical images, together with clinical, physiological, and social data, for the benefit of human health. eMedLab has almost one hundred users currently, from across the project partners and other institutions and industry.

> *"eMedLab has allowed our group to work with a whole genome dataset which couldn't possibly be accommodated within our standard computational resource"* – **Dr Samra Turajlic** at the **Francis Crick Institute** uses eMedLab to analyse kidney cancer genomes.

Discovery for medicine

Introduction

The MRC continues to support fundamental research aimed at better understanding biological processes. This 'blue skies research' provides the basic knowledge that opens entirely new approaches to medicine. During the 2017 HEFCE conference, Jo Johnson MP reminded the audience that "unanticipated scientific breakthroughs can turn out to be even more valuable than the outcomes of agenda-driven research."

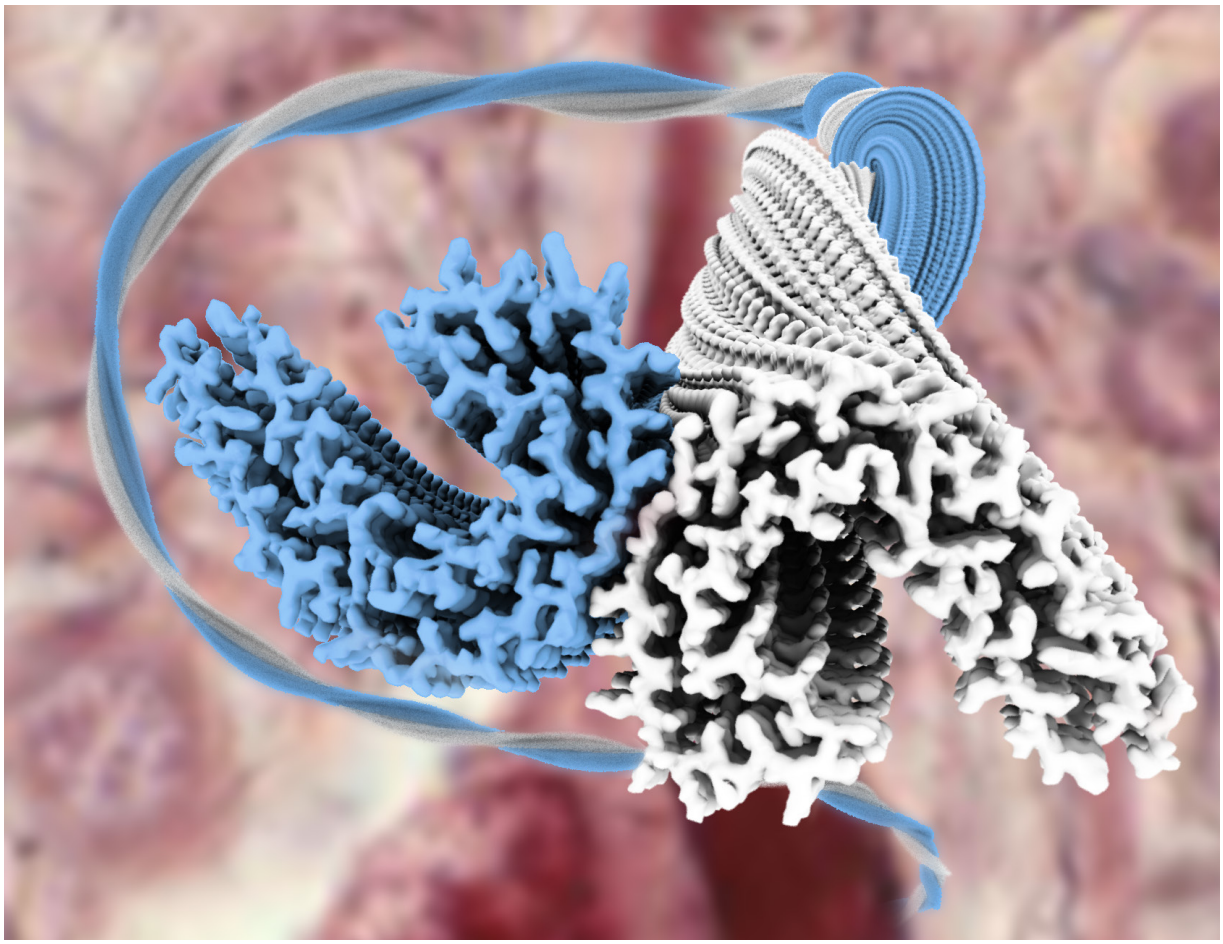
Many of the foundations of modern medicine were serendipitous: for example, Alexander Fleming's 'accidental' discovery of penicillin and Peter Mansfield's efforts to improve x-ray crystallography which created MRI.

The high-quality discovery science delivered across the MRC's portfolio combine with targeted funding to tackle the challenges of the 21st century. This work is both highly regarded and attracts the highest levels of international citation.

Structure of key dementia protein unlocked using Nobel Prize-winning technology

Researchers at the MRC Laboratory of Molecular Biology have combined 30 years of research knowledge with Nobel Prize winning new techniques to visualise the 3D atomic structure of a key protein involved in dementias. With more than 850,000 people living with dementia in the UK, this knowledge brings us one step closer towards developing new treatments for dementia by 2025.

The MRC has a long-standing history of supporting excellent discovery science. As such, MRC-funded research has raised the international reputation of UK science. The significance of cryo-EM in revolutionising our ability to look at biologically important molecules in unprecedented detail was highlighted when Dr Richard Henderson was awarded the 2017 Nobel Prize in Chemistry.



A depiction of tau filament structures (blue and white) overlaid on a microphotograph of neurons in Alzheimer's disease. Image Credit: MRC Laboratory of Molecular Biology.

In July 2017, scientists at the MRC Laboratory of Molecular Biology (LMB) revealed the atomic structure of tau protein, a key molecule involved in dementias such as Alzheimer's disease. Tau proteins form abnormal filaments inside nerve cells, and understanding the structures of these filaments will be key in developing drugs to prevent their formation.

Dementia costs the UK economy an estimated £26 billion a year. Currently there are 850,000 people in the UK living with dementia, and this number is set to rise as the UK and other European countries have an increasingly ageing population. The societal and economic burden of dementia is set to increase dramatically unless new medical breakthroughs can be found.

The recent breakthrough in visualising tau protein is the result of painstaking effort by Dr Michel Goedert and his team at the LMB. Understanding the structure of tau protein was eventually possible only because of the improvement of cryo-electron microscopy in the 1990s that allows the detailed atomic structure of molecules to be visualised. Cryo-EM was developed by scientists at the LMB, and subsequent improvements to cryo-EM techniques by the team led to the development of better detectors for electron microscopes and better software to analyse the images of proteins. These technological improvements in cryo-EM paved the way for Dr Goedert and his team to finally identify the atomic structure of tau protein filaments.

The MRC's strategy for long-term investment in discovery research is validated by these research impacts, and further demonstrates the fruitful results of excellent science through developing new technologies to solve technical and conceptual problems.

> *"Until now the high-resolution structures of tau or any other disease-causing filaments from human brain tissue have remained unknown. This new work will help to develop better compounds for diagnosing and treating Alzheimer's and other diseases which involve defective tau."* – **Michel Goedert, MRC Laboratory of Molecular Biology**

Continuing investments in success

Expanding Cryo-EM

The MRC is committed to expanding the support for Cryo-EM in the future. In July 2017 the Minister for Universities, Science, Research and Innovation, Jo Johnson MP, announced a new £11.3 million commitment to boost the burgeoning field of Cryo-EM in the UK, with awards to the universities of Glasgow, Oxford and Leicester. In October 2017 the Chancellor, Philip Hammond MP, announced a further £5 million towards Cryo-EM to help drug discovery to become faster and cheaper.

UK DRI researchers in-place

Similarly, the MRC will continue to support fundamental research in neuroscience and, in partnership with medical charities Alzheimer's Society and Alzheimer's Research UK, is investing £250 million in a new **UK Dementia Research Institute** (UK DRI). The UK DRI will build on groundwork from the MRC's £53 million Dementias Research Platform UK (DPUK) and the NIHR-DRI Translational Collaboration in Dementia Research to lead the UK's dementia research efforts. The progress towards UK DRI in 2016/17 includes a series of momentum awards, appointment of institute director, **Professor Bart de Strooper**, and announcement of the centres across the UK.

Royal opening for the Francis Crick Institute

In November 2016, Her Majesty The Queen, accompanied by The Duke of Edinburgh and Duke of York, officially opened the £650 million Francis Crick Institute in London. Founded by the MRC and its charitable and academic partners, the Crick Institute brings together 1,250 scientists and a further 250 support staff from across disciplines to tackle the pressing health concerns of the 21st century.

While newly open, the Crick is already producing game changing research. Their recent *Nature* paper reveals how a team of researchers at the Crick have used genome editing techniques for the first time to throw light on the earliest processes in embryonic development.

Global recognition for MRC science

While there is a plethora of mechanisms by which information can be disseminated, formal publication remains the primary output of scientific research output. Dedicated journals publishing peer-reviewed research findings have existed for 350 years, and journal articles account for more than half of all outputs reported to MRC by our researchers.

As a whole, the UK punches above its weight in R&D, and is ranked number one in the world for biomedical research[1], an accolade to which MRC certainly contributes. In 2016, there were 10,981 unique publications on MRC-funded research reported. This brings the total number of unique publications reported since 2006 to 96,443. Citation analysis can provide evidence for how influential a given article is within the context of its time and field of research. Analysis of publications across the fields of biological sciences, clinical medicine and health/medical-related research shows MRC publications cited ahead of the rest of the UK and other comparator research-intensive nations with an average field-normalised citation impact (NCIf)[2] score twice the world average (MRC = 2.08 vs. other UK = 1.47, USA = 1.31, see Figure 1 below).

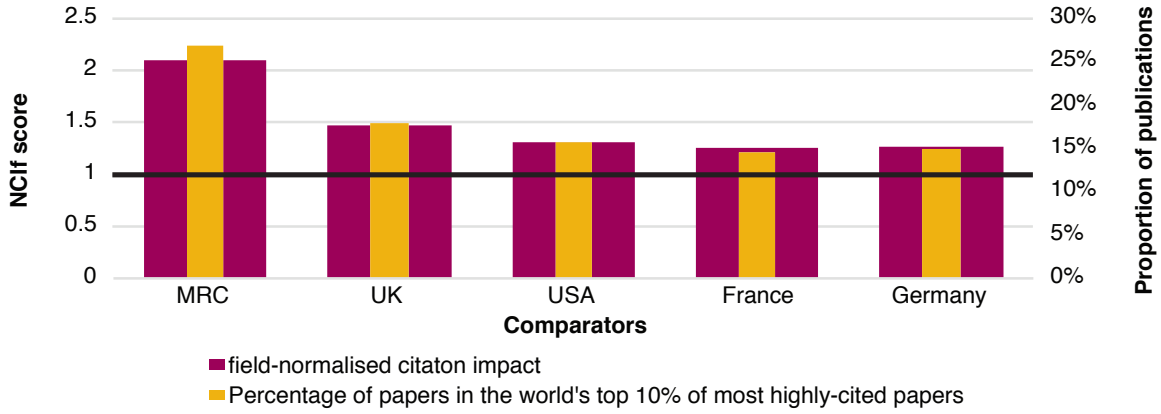


Figure 1 – Comparison of MRC publications in biological sciences, clinical medicine and health/medical research and the UK and other research-intensive nations, by field-normalised citation impact

To support rapid dissemination of research results, the MRC is now actively encouraging investigators to share their pre-peer reviewed manuscripts via established preprint servers. These pre-print references will be replaced by published article when available. In addition, the MRC recognises the need to use metrics responsibly, with recognition of the limitations of how such data can be interpreted. Internationally supported statements such as the San Francisco Declaration on Research Assessment (DORA) and the Leiden Manifesto highlight the care that should be taken over the use of metrics in research assessment. The UK's own expert review of the area published as the "Metric Tide" report[3] sets out a comprehensive set of recommendations to improve research assessment and management.

1 Based on field weighted citation impact (FWCI) for biological science, clinical science and health & medical science in Department for Business, Energy and Industrial Strategy (2017) *International comparative performance of the UK research base 2016*. Published online, last accessed 10/12/17 http://bit.ly/2kI0VWe

2 The MRC sources its citation data for publications from Clarivate Analytics, which sources data from 18,000 journals in its Web of Science core collection. The main indicator of citation rate is field-normalised citation impact (NCIf), which accounts for both the field of research and the year of publication in the analysis. Therefore a NCIf score of 1 is considered the global average for publications in a given field and year.

3 Wilsdon et al. (2015) *The Metric Tide: report of the independent review of the role of metrics in research assessment and management*. DOI: 10.13140/RG.2.1.4929.1363

Transforming health research and innovation

Partnering with Industry

In 2015, the total expenditure on research and development in the UK was calculated as £32 billion[4], equivalent to £486 per head of population. Almost 70% of this was provided by the private sector. A 2014 estimate suggested that at least £8.5 billion of this was relevant to health with 48% provided by the private sector[5]. Partnerships and collaboration to maximise the expertise, facilities and resources available across the public, charity and privately funded sectors are essential to maintain UK excellence in the life sciences.

Recent years have seen dramatic changes in the way MRC engages with industry. This includes the initiation of completely new ways of working with companies: the establishment of the £180 million Biomedical Catalyst in partnership with Innovate UK to speed up the development of new interventions, the development of disease-specific consortia to investigate differential patient response to drugs (see UK-PBC case study), and a joint initiative with AstraZeneca making available clinical compounds to better understand diseases. We will further expand the concept of bringing together the best clinical scientists with patient networks and industry partners to better define diseases and develop more tailored treatments and will widen our range of partnerships with industry.

In a recent assessment of over 10,000 MRC awards made since 2006, 16% show evidence of interactions with the private sector; 5% leveraging cash (to a value of £67 million in 2015/16) and a further 11% 'in-kind' contributions. These in-kind contributions are predominantly intellectual, provision of patient-directed expertise, but can be more tangible, such as access to facilities or supply of unique clinically-relevant materials. Private companies can have specialised resources unavailable to academic researchers, particularly in areas of high-throughput screening and rapid, efficient production facilities. Such contributions, cannot be directly valued, but will be by far the most significant part of the contribution from the private sector. For example, the £20-50 million cost of development of a single proprietary compound to phase I-II status[6] would be a prohibitive barrier to research in the area. However, strong relationships with seven major pharmaceutical companies has secured access to dozens of these compounds for researchers, opening previously impossible avenues of research. Looking at 2016 alone, as a result of their MRC award, researchers have reported more than 18,945 new collaborations including 1,821 within the private sector. Around 43% of new collaborations are made with international partners (16% in Europe, 12% in the United States).

4 Office for National Statistics (2015) *UK gross domestic expenditure on research and development: 2015*. Last accessed 06/11/2017 http://bit.ly/2y9qs74
5 UK Clinical Research Collaboration (2015) *UK Health Research Analysis 2014*. ISBN: 978-0-903730-20-4.
6 Mestre-Ferrandiz *et al.* for the Office for Health Economics (2012) *The R&D cost of a new medicine*. ISBN: 978-1-899040-19-3

MRC support for partnerships with industry

> *"The MRC is a world-leader in forging links between industry and universities and academics. Academic partners benefit from working hand in hand with industry counterparts from the earliest stages of research through to the development of new products and treatments. The MRC is encouraging other companies, large and small, to join in this innovative MRC collaboration designed to speed up the translation of basic science into real health benefits for patients."* **– Dr Chris Watkins, Director of Translational Research and Industry**

The MRC has several award schemes aimed at accelerating the translation of discovery science into healthcare innovation. These include the Developmental Pathway Funding Scheme (DPFS), Stratified Medicine Initiative (SMI), Biomedical Catalyst (BC), and the Confidence in Concept (CinC) scheme with its partnered Proximity to Discovery (P2D) initiative (see Figure 2, below). Collectively these schemes have spent more than £176 million in award funding over the past five years.

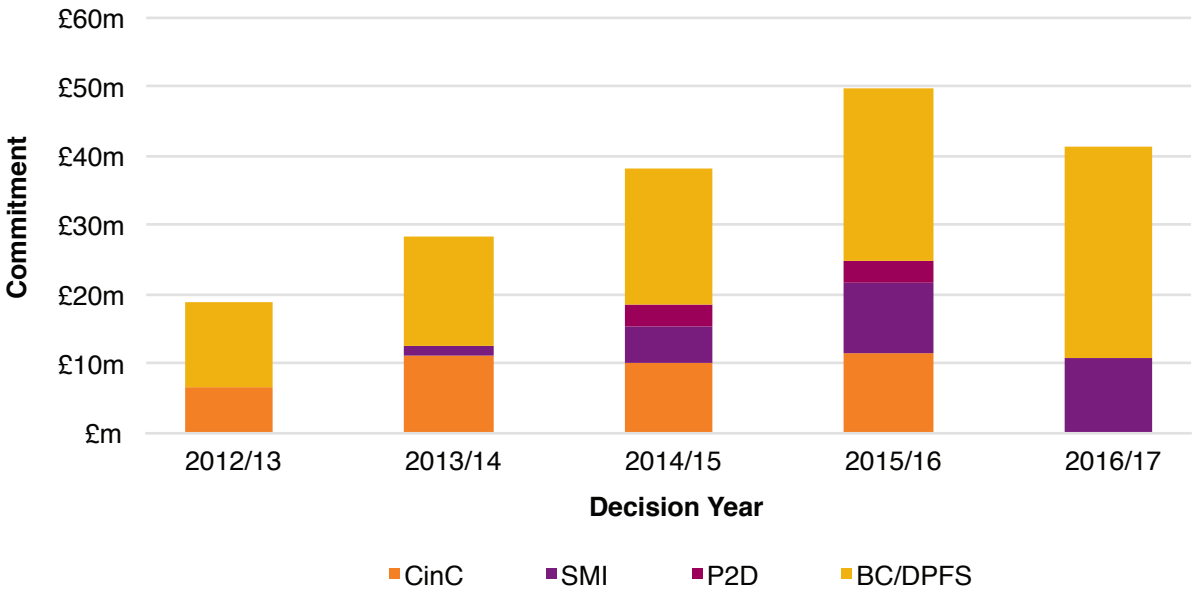
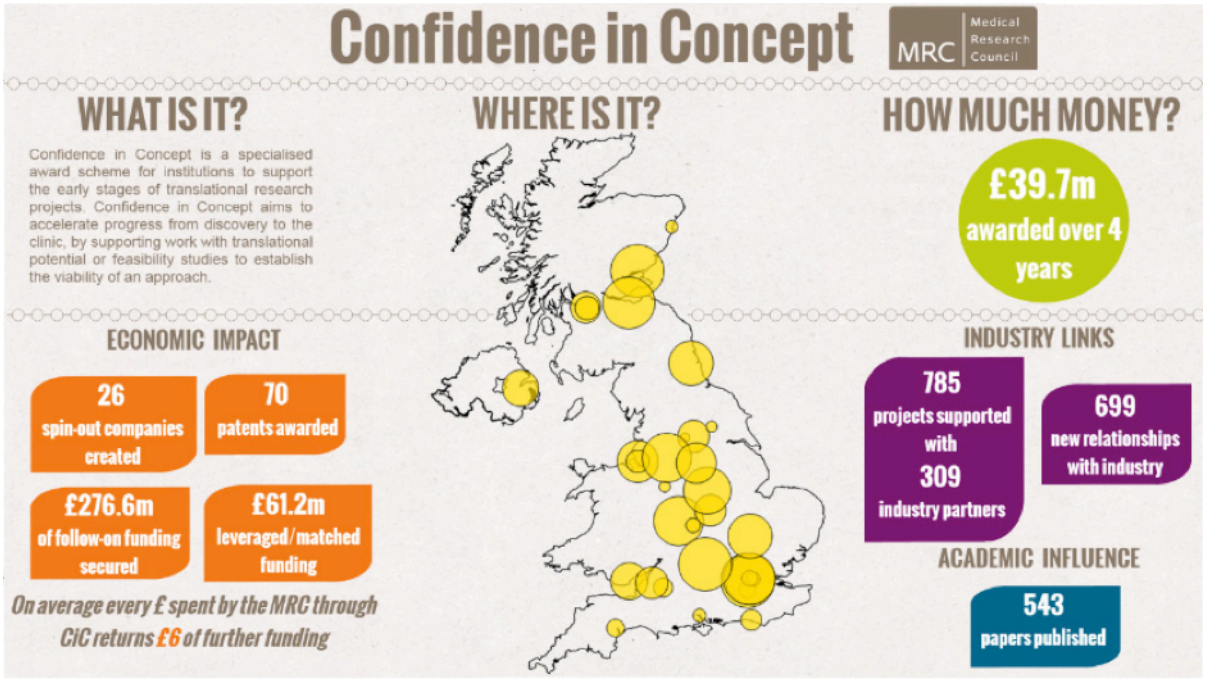


Figure 2 – MRC support for translational research and industry collaboration

The MRC has collaborated with six global drug companies to form a new scheme that allows academic researchers access to a collection of nearly 50 de-prioritised pharmaceutical compounds and up to £5 million in funding. In addition, Industrial Collaborative Awards in Science and Engineering (CASE) studentships provide students with experience of collaborative research in a non-academic, industrial environment. It is also possible to apply for research funding for a collaborative project with an industry partner through the MRC Industry Collaboration Agreement (MICA). It provides a legal format for the agreement between the commercial and academic partners to undertake collaborative research. The key feature of the MICA is its flexibility, allowing the level and nature of the industry contribution to vary according to scientific needs, from cash and time input to sharing compounds and staff. Companies of any size may participate, from spin-outs and SMEs to major pharmaceutical companies.

The MRC can also help establish new collaborations between academic and private sector research. These range from holding workshops or symposia which act as networking opportunities, or identifying specific partnership opportunities.



Impact highlights from the MRC Translation award schemes in 2016 include:

- **Vaccitech** was launched with £10 million seed funding to develop intellectual outputs of DPFS-funded research into a universal flu vaccine, which is showing promise in clinical trials.

- In November 2016, **Orchid Therapeutics**, received an additional $20 million to fund a large clinical trial of a gene therapy intervention for Severe Combined Immunodeficiency (ADA-SCID) (developed by Professor Bobby Gaspar, UCL) and formed a strategic alliance with a world-leading company in gene and cell therapy, Oxford BioMedica PLC.

- **GammaDelta Therapeutics**, a spinout company founded by scientists from the Francis Crick Institute, King's College London (MC_PC_14105) and Cancer Research UK announced further expansion after gaining £100 million worth of investment earlier this year. The company have advertised another 25 jobs to develop the drugs of the future.

MRC initiative is instrumental in getting new drug for rare liver disease approved

The **UK-PBC** consortium, established via the MRC's **Stratified Medicine Initiative**, progressed the results of their phase III trials, completed in 2016 through to EU market validation within a single year. Ocaliva, a treatment for the liver disease Primary Biliary Cirrhosis (PBC), was developed through the **MRC co-ordinated academic/industry consortium UK-PBC**. In late 2016, an independent advisory committee voted 17 to 0 to support the US' FDA approval of Ocaliva which will now be the first new drug approved for use in PBC in 20 years. FDA validation was followed quickly by EU Marketing Authorisation in January 2017. NICE approved the treatment in the UK in March 2017 following UK-PBC evidence given at the review panel. The NHS is expected to make Ocaliva available to patients in the next few months to **benefit the 50,000 people in the UK** who suffer from PBC. Globally the sales of Ocaliva are estimated at $108 million in 2017 and may reach $1.6 billion by 2020[7].

> *"Funding from the MRC Stratified Medicine Initiative has quite simply transformed PBC. The support has allowed us to work with our patient partners in the PBC Foundation and LIVERNORTH to develop the largest and best characterised patient cohort in the world (7,000 patients which equates to about 40% of all UK patients). Our work helped develop the first new treatment in PBC in a generation; OCA (Ocaliva), is now approved in Europe and the USA, with a pipeline of further treatments. These new treatments, the increased understanding of the disease, and the empowerment of patients who are equal partners in the enterprise mean that the use of the word transform is fully justified. We have shown that with the support of the MRC Stratified Medicine Initiative, therapy can be developed in rare diseases such as PBC. We think this provides an exciting model for how we can approach other rare diseases in the future"* **– Professor David Jones, UK-PBC Director, University of Newcastle**

7 Biospace (2016) *Why Intercept Pharma Just Became an Even More Attractive Takeover Target*. News article from 01 June 2016. Last accessed 06 Nov 2017 http://bit.ly/2ziTVIJ

Patents arising from MRC research

MRC-funded researchers provide MRC with first-hand accounts of their work directly developing their intellectual property via researchfish®. In 2016, there were 99 reports of new IP being created, of which 67 were granted in 2016 (see Figure 3). This brings the total reports on intellectual property from MRC researchers in researchfish® to 1,471. Overall, **8% of MRC awards directly contribute to new intellectual property.**

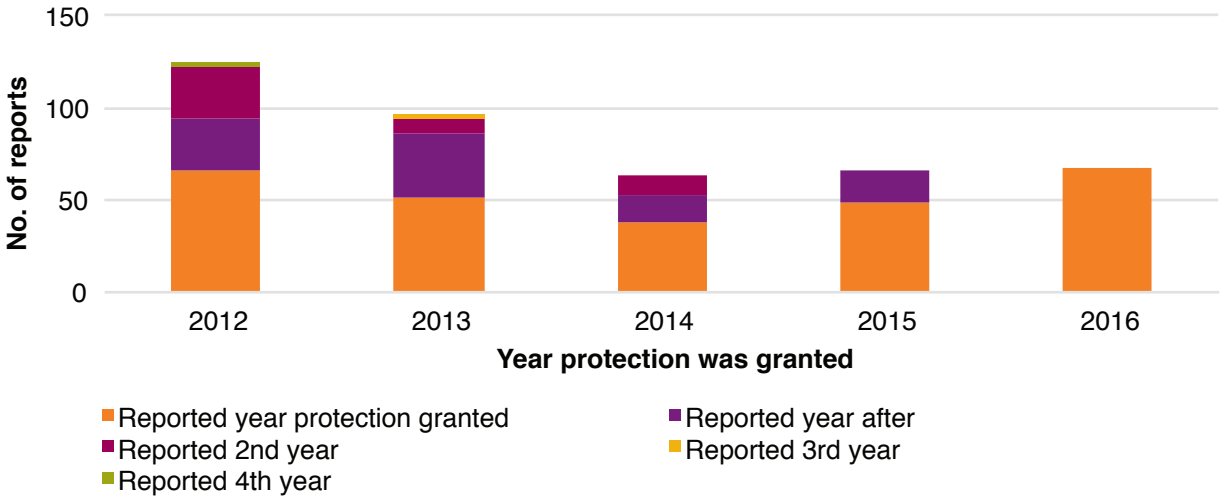


Figure 3 – Intellectual property reported via researchfish® in the past five years

However, these reports of direct contribution to the application for a new patent ignore the wider scientific knowledge that is drawn upon to support patent applications. A larger number of projects collectively can advance scientific understanding which eventually leads to intellectual property. By examining the publications cited in patent applications we can show how the knowledge derived from MRC research indirectly contributes to new medicines and medical technology development.

Analysis of patent documents shows MRC-funded research is cited in more than 20,000 different patents[8]; 8,626 MRC-funded publications have been cited in the patent literature, linking to 20,180 different patent documents and 14,252 patent families. Linking these back to MRC grants indicates that approximately **37% of MRC awards contribute to global intellectual property**. These results are comparable to the US' National Institutes of Health (NIH), where similar methodology to assess direct and indirect linking of patents to awards showed 8.4% and 31% respectively[9].

8 Recent developments by The Lens – an open source global cyberinfrastructure initiative – allows rapid searches of references to the MRC's portfolio of 90,000+ publications in the patent literature via their PatCite application.

9 Li *et al.* (2017) The applied value of public investments in biomedical research. *Science* **356**(6333) p78-81 DOI: 10.1126/science.aal0010

Spinouts arising from MRC research

The MRC has helped found or develop at least 195 spin out companies, of which 72 have arisen in the last five years and 16 in 2016. Of the 195, 157 companies are still active. Both active companies and those no longer trading have an average duration of over eight years from incorporation date (see Figure 4, below).

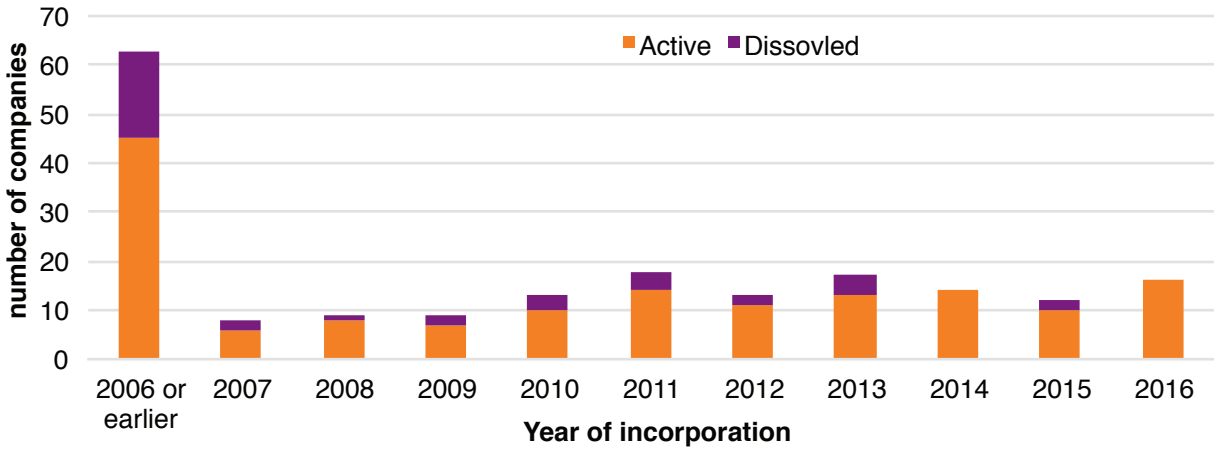


Figure 4 – MRC spinouts, both active and dissolved, by incorporation date

By combining researchfish®, wider spinout reports and information from Companies House, we can begin to elucidate how MRC-derived spinouts impact on the private sector. Of the 195 companies, 13 are based outside the UK and 22 did not have associated business data (dormant/non-trading/unknown). Of the remaining 160 UK-based companies formed as a result of MRC support the majority are, as one might expect, in the biotechnology, pharmaceutical and healthcare sectors (94, 59%). A further (40, 25%) were in other areas of science, engineering and R&D while remainder focus on other forms of manufacture, data/IT or support services /intellectual property (see Figure 5, below).

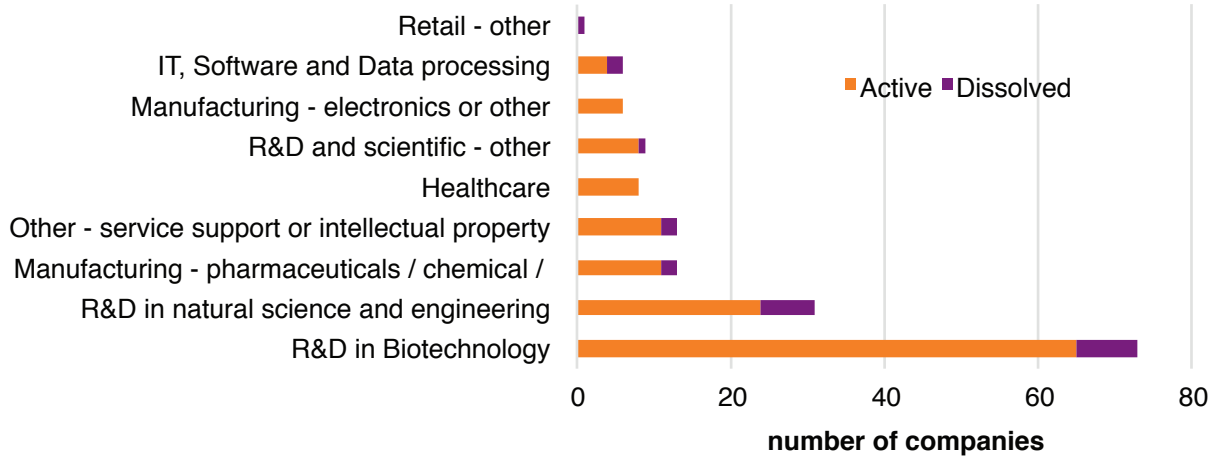


Figure 5 – The business type of MRC spinouts, by standard industrial classification (SIC) group

Employees, investment and turnover

Researchers provide actual or estimated range of employee numbers for spinouts through researchfish®. From these data, we can estimate 1,066 jobs have been created through spinout companies arising from MRC funding, of which 832 are with companies active today[10].

In addition, UK companies are required to submit accounts to Companies House, although the level of statutory detail required varies (for example, if 'small', less than £10.2 million or less than 50 employees, only abridged accounts are required). Consequently, only a relatively small proportion of spinouts have data on turnover or employee numbers[11]. However, of those that do report such information, MRC spinouts have created 723 jobs with a turnover of £75.6 million.

While data on investment in small companies are similarly restricted, an analysis into investments in RCUK spinouts provided records of 28 companies developed from MRC-supported research. These companies alone reported investments of £602 million across 83 rounds of investment fundraising (an average of 2.9 rounds per company)[12].

10 There were 176 companies reported in researchfish® with a figure or range (1-5, 6-9, 10-15 etc.) for employee numbers. The range average (2.5, 7.5, 12.5 etc.) was used to approximate total number of jobs created.
11 Only 21 companies have reported latest operating revenue (turnover) and only 27 report employee numbers.
12 Source: Beauhurst Ltd. http://about.beauhurst.com

Bicycle Therapeutics announces partnership with AstraZeneca in $1bn deal

In 2016, Bicycle Therapeutics, a MRC spinout company, entered into collaboration with AstraZeneca potentially worth $1 billion. The collaboration will identify and develop novel peptides, compounds consisting of two or more amino acids linked in a chain, to treat respiratory, cardiovascular and metabolic diseases.

Formed in 2009, Bicycle Therapeutics is the brainchild of **Sir Gregory Winter** at the **MRC Laboratory of Molecular Biology** (LMB) with the ambition to develop a new class of drugs. Most drugs are small molecules that are chemically synthesised and taken in orally; others, like antibodies, are large protein molecules made biologically and injected into patients. The work by Sir Gregory and his team have combined the high target specificity of antibodies and the small, easily absorbed properties of traditional drugs to develop a new, unique class of drug, known as bicyclic peptides or Bicycles®. These breakthroughs, alongside the ability to adjust how long the Bicycles® can be active in the body (the 'half-life') which reduces toxicity have helped launch Bicycle Therapeutics as a spin out company to further develop the knowledge derived from MRC-funded research.

In the new 2016 agreement with AstraZeneca (AZ), Bicycle Therapeutics is responsible for identifying Bicycles® for targets specified by AZ while AZ is responsible for further development and product commercialisation. If all planned programmes reach the market, Bicycle Therapeutics will be eligible for more than $1 billion in payments. The MRC spinout would also be entitled to receive royalties on sales of products resulting from the collaboration.

Also in 2016, Bicycle Therapeutics received sponsorship and funding from Cancer Research UK for a Phase I clinical trial of a drug in patients with advanced solid tumours including triple negative breast cancer and non-small cell lung cancer. Finally, in recognition of its innovative technology, Bicycle Therapeutics was named by *Business Weekly* as the winner of its 2017 Disruptive Technology Award.

Since its start in 2009, Bicycle Therapeutics has moved from strength to strength and partnerships such as these help accelerate the progress of research to improve human health.

Evaluation of Impact

The MRC has also supported a range of studies aimed at better understanding impact and refining estimates of the economic return on investment from medical research. In 2008 the first "What's it worth?" report[13], commissioned by the MRC, Wellcome Trust and Academy of Medical Science, found that cardiovascular disease research generated a 9% return on investment in terms of the health gain from new interventions. This approach was also used to assess mental health (7% net health gain[14]) and subsequently used to estimate the average health gain from cancer research (10%)[15]. The third and last of the "What's it worth?" series, applying the same methodology to musculoskeletal disease research, was published in January 2018[16].

In 2016 MRC funded research provided the first UK-specific estimate of spillover benefits from medical research[17]. The analysis concluded that investment in medical research had stimulated the private sector to invest more in UK research and development, equivalent to a return on investment from public and charitable funding for medical research of 15% to 18%. When added to the average net health gain from musculoskeletal, cancer, cardiovascular and mental health research, the total return on investment from medical research is estimated to be 25%.

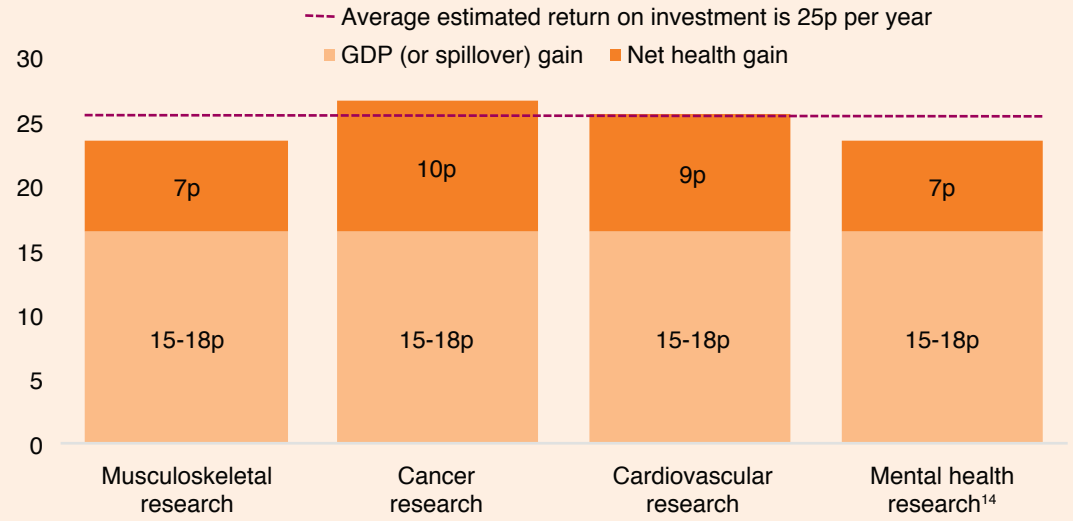


Figure 6 – What is medical research worth? Equivalent yearly return from £1 of public or charity investment

13 HERG, OHE, RAND Europe (2008) *Medical Research: What's it worth? Estimating the economic benefits from medical research in the UK*. London: UK Evaluation Forum. Available via MRC website: https://www.mrc.ac.uk/publications/browse/medical-research-whats-it-worth/

14 Note that the figure for mental health research was derived from a more limited study in the 2008 report, and is subject to greater uncertainty than the other figures.

15 Glover et al. (2014) Estimating the returns to UK publicly funded cancer-related research in terms of the net value of improved health outcomes. *BMC Medicine* **12**:99 DOI: 10.1186/1741-7015-12-99

16 Glover et al. (2018) Estimating the returns to United Kingdom publicly funded musculoskeletal disease research in terms of net value of improved health outcomes. *Health Research Policy and Systems* **16**(1): DOI: 10.1186/s12961-017-0276-7

17 Sussex et al. (2016) Quantifying the economic impact of government and charity funding of medical research on private research and development funding in the United Kingdom. *BMC Medicine* **14**(32): DOI: 10.1186/s12916-016-0564-z

Developing talent and skills

Introduction

Support for training and skills development has always been a key component of the MRC's approach to supporting research. Our varied funding programmes provide universities with core support funding for new studentships, and directs new awards to areas of critical capacity building. For example in January 2017, we revised our approach to skills development fellowships, to encourage interdisciplinarity and career flexibility, and industrial CASE studentship schemes, to promote further academic/industry partnerships.

Likewise, the availability of fellowships and support for clinicians working alongside/within academia provide a vital mechanism to develop new skills, provide flexible support and guidance for researchers at critical career points and further strengthen the capacity of the UK research base. In October 2016, the MRC launched a new interactive 'map' of the funding schemes available to biomedical researchers to help support research careers. In January 2017, we revised our best practice guidelines for clinical academic training.

This supports not only the future of academic research across the UK but also provides a highly skilled workforce where critical thinking, the understanding of complex systems and sophisticated data analysis are highly valuable to the UK knowledge economy.

Employment post-MRC support

The MRC provided direct support to more than 1,900 researchers in 2015/16, with a further 2,100 researchers as co-applicants on research grants. Data from researchfish® can help track the next destinations of researchers and support staff employed as a result of an MRC award (see Figure 7 below). Around two thirds of these employees will continue in an academic or university research post, with 5% migrating to the private sector.

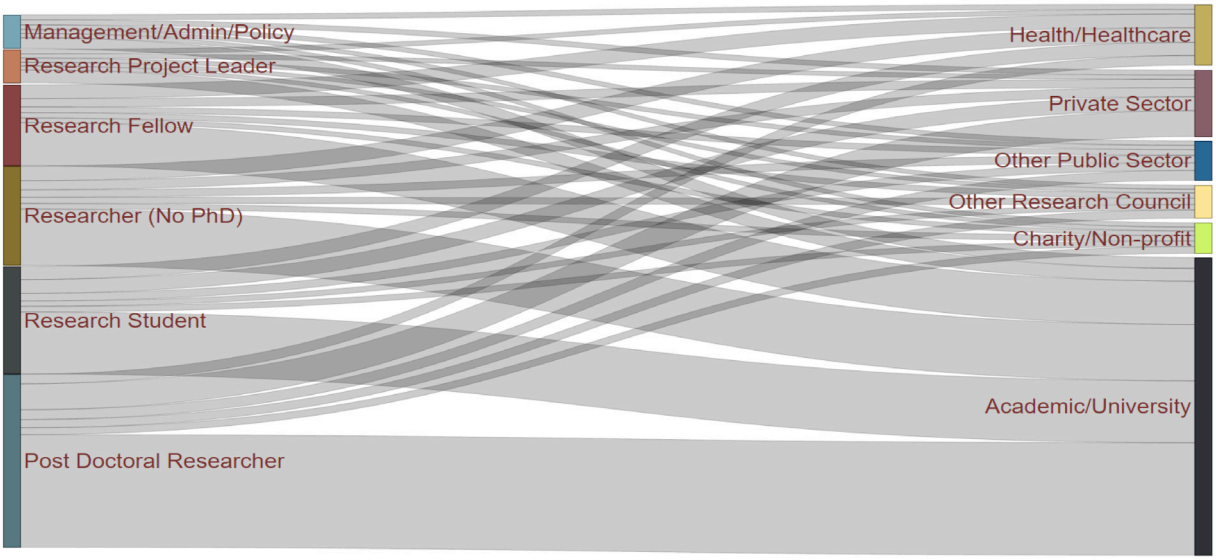


Figure 7 – Alluvial chart to show next destination of staff reported via researchfish®

The MRC supports approximately 400 PhD studentships per year, and more than 98% of MRC PhD students submit a thesis and obtain their PhDs. While the majority continue in academic research positions (see Figure 8 below) almost a third enter employment in the private sector.

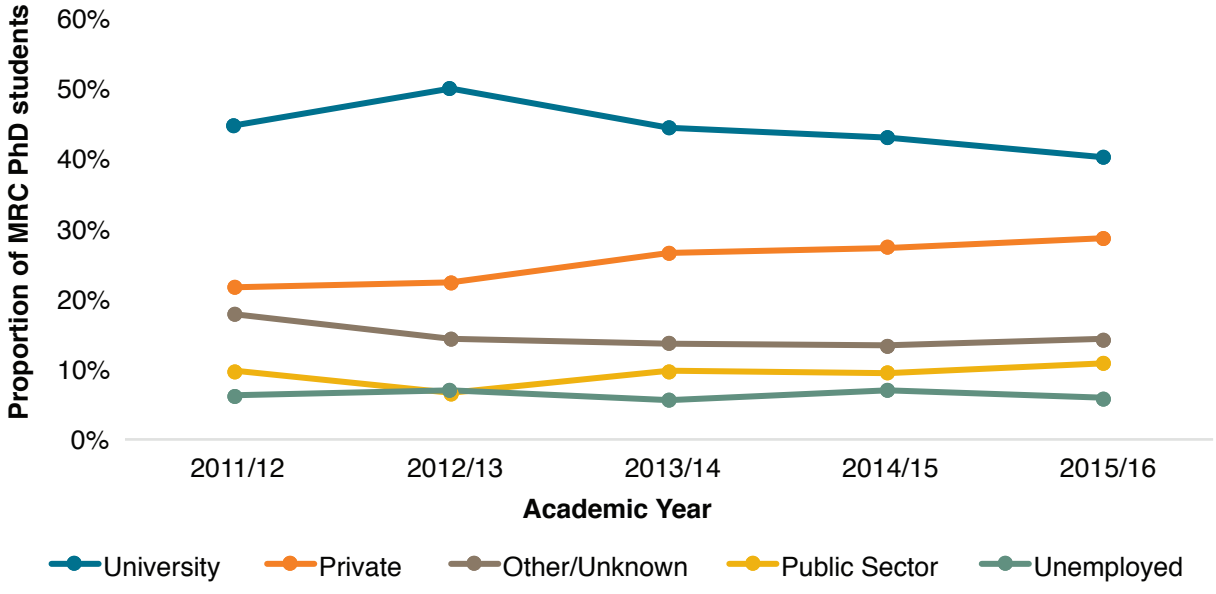


Figure 8 – Employment status of MRC PhD students six months after completing study, by employment sector.

Celebrating science

Part of the MRC's mission is to bring the benefits of excellent research to all sections of society: from policymakers and parliamentarians to research participants and the public. MRC Festival of Medical Research provides an opportunity to give an account of our research, to ensure that public views and concerns are reflected in our decision-making and to build public trust in the MRC and the research it funds.

MRC Festival of Medical Research attracts thousands of visitors

The first MRC Festival of Medical Research took place from 18 to 26 June 2016 with events running up and down the country. Following its success, a second festival was held from 17 to 25 June 2017.

The festival had three main aims:

- To engage the MRC community to increase understanding of the MRC's strategic aims and their own contribution to these
- To build trust in medical research by sharing MRC-funded research with others
- To increase awareness and understanding of the benefits of medical research to society

In 2016, 35 MRC establishments and one collective group of MRC-funded researchers ran 52 festival activities, involving more than 6,000 visitors and 1,100 staff and students at events across the UK and The Gambia. In 2017, this grew with 39 establishments and one collective delivering 54 separate activities, attracting more than 11,000 visitors to events in the UK, The Gambia and Uganda.

In 2017, 74% of festival activity organisers felt that, through their involvement in the festival, their staff and students had gained a better understanding of the MRC's strategic aims and 97% of organisers felt that their audiences had increased their awareness and understanding of the benefits of medical research.

One festival visitor said: "It really got me thinking about the amount of sugar in my meal deal that I eat most days! I can reduce my sugar intake with a few easy swaps." Another said: "Delighted to see our taxes being put to such excellent use. Without exception, I found the scientists to be enthusiastic and engaging and skilled at presenting complex ideas at a level which we could understand (or at least appreciate)."

A third MRC Festival of Medical Research has been announced for 2018, with an extended timetable, running from 14 to 24 June 2018.

Annexes

Annex 1 – Reporting Requirements and Methodology

Introduction

The MRC Impact Report has been published each year since 2005 and is part of the research councils' performance management framework implemented by the Department for Business, Energy and Industrial Strategy (BEIS). All of the *MRC's Impact Reports* are available on the MRC website.

In 2014, the Research Councils established a harmonised method for the collection of research outputs and outcomes data via researchfish®[18]. This provided a good opportunity to review the common indicators in the *Impact Reports*, with a view particularly to extending the harmonisation of quantitative data. In April 2016, the Research Councils agreed a revised set of common indicators for our *Impact Reports*. While similar previous reporting requirements benefit from a more uniform methodological approach.

The list of common indicators currently agreed between BEIS and the research councils can be found in Annex 2. Each research council also presents a number of additional metrics and narrative information to ensure the report reflects the full range of activities undertaken by that council. The *MRC Impact Report* includes data covering the last five years, with some data extended further back where available.

In addition to the raw metric data, this report also includes further details on the inputs, outputs and outcomes required, including some example case studies. Further information on each study can be found on the Research Councils UK (RCUK)'s information portal— the Gateway to Research[19] — by entering the project reference number listed under each case study in the search field or following the link provided.

It is important to note that the data and case studies featured in this report represent only a small proportion of the data collected annually by MRC. More details and further case studies can be found on our *Investing for Impact* web pages and in other MRC publications such as *MRC Annual Report and Accounts 2016/17*[20] and the *MRC Outputs, Outcomes and Impact Report 2016*[21]. All MRC publications can be found on the MRC website.

18 researchfish® is a registered trademark of Researchfish Limited: https://www.researchfish.com/
19 Research Councils UK Gateway to Research. http://gtr.rcuk.ac.uk/
20 MRC Annual Report and Accounts 2016/17: https://www.mrc.ac.uk/publications/browse/annual-report-and-accounts-2016-17/
21 MRC Outputs, outcomes and impact of MRC research 2016: http://www.mrc.ac.uk/successes/investing-for-impact/outputs-from-mrc-research/

Data collection and analysis: researchfish® and the use of outputs, outcomes and impact data

The MRC's evaluation programme focusses on capturing evidence to track the progress, productivity and quality of the research the MRC funds. One route for doing this is through researchfish®, the online system used by researchers to provide feedback on the outputs and impact of their work. Outputs and outcomes include **publications** and academic **collaborations**, new **medical products** and technologies that advance understanding and provide evidence for **policy** improvement. Economic impacts may arise, such as obtaining **further funding** for continued research, commercialising **intellectual property** and establishing **spinouts**. Our approach to capturing feedback about outputs is shared across all seven research councils and many other UK and international funders, providing the capability to identify a wide range of outputs across the UK research base, and better understand how these contribute to economic and societal impact.

The MRC uses this detailed view of research output to communicate the benefits of medical research to Government, the public and other stakeholders, to evaluate funding mechanisms (for example, schemes and units), and to review its portfolio. Examples of evaluation projects include the 2015/16 MRC-led evaluation of the multi-funder National Preventative Research Initiative (NPRI)[22], ongoing work to assess the benefits of establishing the Francis Crick Institute, and to evaluate the benefits of transferring MRC Units to University ownership. This *MRC Impact Report*, our *Investing for Impact* webpages and *MRC Annual Report and Accounts* are examples of publications that include a broad range of analyses and case studies highlighting how MRC research influences wider society.

In 2014 all seven research councils joined researchfish®, become part of a community consisting of over 100,000 researchers reporting in, over 2,000,000 outcomes on over 100,000 awards and over £45 billion worth of funding[23].

Researchers can enter, amend and update information in researchfish® all year round, but the MRC requires researchers to submit a return in the system once a year[24] for the lifetime of the award and a number of years beyond. This means that numbers reported this year will be different to those reported previously as researchers can continue to add information retrospectively to provide a fuller account of research progress.

It is also important to note that there will some variations in analysis between reporting periods, as the modifications to the researchfish® question sets, data processing/cleaning (de-duplication, disambiguation etc.) and changes in coding practice will affect some data outputs. Therefore, while data presented here may be found in other researchfish® reports and MRC publications, there may be some slight differences in the figures reported.

The latest reporting year (2016) was the ninth year that MRC researchers used the system, with a new data collection period running in February and March 2017. The compliance rate for this submission period was 95%, with 5,955 responses from 6,269 awards.

22 NPRI Scientific Review Group (2015). NPRI: Initiative outcomes and future approaches. Published by MRC online, September 2015. Last accessed 31/10/16. http://www.mrc.ac.uk/publications/browse/national-prevention-research-initiative-npri-report-2015/

23 The researchfish® system is owned and operated by Researchfish Ltd., and is available to all research funders on a subscription basis; http://www.researchfish.com/

24 The researchfish® submission period for 2016 closed in March 2017.

It is important to note that while counts of researchfish® data help illustrate the volume of output information collected, the MRC is primarily interested in the quality of outputs received. Therefore, all outputs reports are extensively reviewed to identify duplicates and to consider whether they meet basic criteria such as being evidenced, justifiably linked to a core MRC programme and occur within the relevant timescale[25]. The main exception to these internal duplication checks are published outputs. The primary aim with publications is to benchmark outputs using a variety of more quantitative bibliometric approaches such as citation indexing. We are most interested in how MRC research contributes to the development of new medicines and technologies, improvements to clinical and public health policies and practices, and how it encourages inward investment to the UK.

Finally, while researchfish® data are used for the majority of outputs within this report, MRC collects data from additional sources to provide further information on our activities. These include bibliometric data from Clarivate Analytics, studentship information from the Joint Electronic Submission (JeS) service and Higher Education Statistics Agency (HESA) and internal MRC grant/financial systems.

For more details on reporting methodology, please see our dedicated webpage: https://www.mrc.ac.uk/successes/evaluating-research-outcomes/methodology-for-evaluation/

25 In particular, in a slight modification to earlier analyses, outputs dated before award start dates are not included in the figures reported.

Annex 2 – RCUK common Indicators

Introduction

The research councils have agreed a revised set of common indicators on performance with the Department of Business, Energy & Industrial Strategy (BEIS). These indicators draw on information from grants databases and the researchfish® system.

researchfish® is an online system supported by Researchfish Ltd. It is used by research councils to collect information on the outputs, outcomes and impacts of RC-funded research. Outcomes can be entered into researchfish® at any time, but once a year there is a formal submission period when researchers are required to confirm that their outcomes information is accurate and up-to-date.

Notes on Common Indicators data

The outcomes data included in the Common Indicators are not static. Researchers can enter data retrospectively, which may result in changes to individual indicators in subsequent Impact Reports.

A particular output, for example a publication or a collaboration, might have arisen from more than one award. In this report, a particular output is always reported against each individual award where the unit of analysis is at the award level (for example the proportion of awards reporting a particular output). Duplicate outputs are removed, where possible, in analyses at the level of the type of output generated. Duplicate outputs are removed using system-generated codes to indicate when a researcher has attributed an output to more than one award. This cannot identify duplicate outputs where researchers have entered similar information independently of one another.

Percentages in this report are rounded up or down to the nearest whole number and so some may appear as zero if this represents less than half of 1%.

Additional information on individual indicators is provided below. The Common Question Set used by researchfish® is available from the Researchfish website (www.researchfish.com).

Table 1: Total Funds Available

	2012/13		2013/14		2014/15		2015/16		2016/17	
1.1 Budget allocation	656.2		725.8		703.5		797.8		654.5	
1.2 Leverage total amount	68.3		66.9		61.7		65.7		62.3	
1.2.1 Leverage from private sector	49.2	72.0%	48.3	72.2%	41.6	67.4%	39.6	60.3%	40.4	64.9%
1.2.2 Leverage from other Research Councils	15.7	23.0%	15.1	22.6%	16.6	26.9%	16.6	25.3%	14.4	23.1%
1.2.3 Leverage from other sources	3.4	5.0%	3.5	5.2%	3.5	5.7%	9.5	14.5%	7.5	12.0%
1.3 Total further funds leveraged by projects	35.2		21.8		42.7		13.6		8.9	
1.3.1 Funds leveraged by projects – private	11.9	33.8%	16.0	73.7%	28.7*	67.3%	10.8	78.8%	5.0	55.9%
1.3.2 Funds leveraged by projects – public	4.0	11.5%	1.8	8.4%	2.5	5.8%	0.6	4.6%	0.7	7.9%
1.3.3 Funds leveraged by projects – non-profit	0.0	0.1%	0.5	2.3%	4.9	11.4%	0.1	0.8%	0.2	2.1%
1.3.4 Funds leveraged by projects – academic sector	19.2#	54.6%	3.4	15.6%	6.6	15.5%	2.1	15.7%	3.0	34.1%

Notes:

1.1 Figures for Sections 1.1 and 1.2 come directly from the MRC Annual Report 2016/17.

1.3 Figures for Section 1.3 have now been standardised across Research Councils. This indicator reports the cash and in-kind contributions from partner organisations that were listed on the original research proposal. It does not include any further leverage funding that may have arisen during the course of the award. It does not include additional funding leveraged by Research Council Centres, Institutes, and other intramural investments. With these restrictions, the leverage data for MRC presented here is only attributed to approximately half of total expenditure.

\# Uplift in leverage from the academic sector in 2012/13 is attributed to an additional £16.2m to support the hubs for the Farr Institute of Health Informatics Research at Swansea, Manchester and Dundee.

* Uplift in leverage from the private sector in 2014/15 is attributed to an additional £11.5m from the Stratified Medicine Initiative and £7.5m for Medical Bioinformatics.

Table 2: Total Expenditure

	2012/13		2013/14		2014/15		2015/16		2016/17	
2.1 Research expenditure	630.2	74.5%	663.4	76.1%	676.4	76.2%	846.3	79.1%	688.8	82.2%
2.2 Training expenditure	79.5	9.4%	69.9	8.0%	71.1	8.0%	71.0	6.6%	65.7	7.8%
2.3 Other expenditure	135.7	16.1%	138.4	15.9%	140.6	15.8%	152.9	14.3%	83.0	9.9%

Notes:
Figures for Sections 2.1-2.3 come directly from the MRC Annual Report 2016/17. Note the decrease in 'other expenditure' in 2016/17 due to decreased commercial activities costs, resulting from the creation of Life Arc.
'Research expenditure' includes research grants, MRC institutes and units and other dedicated research expenditure such as funding for the Francis Crick institute. This indicator reports all research expenditure. Prior to the 2016 Impact Reports, this indicator was referred to as 'responsive mode expenditure'.

Table 3: Human Capital

	2012/13		2013/14		2014/15		2015/16		2016/17	
3.1(a) Number of PIs (on 1st April)	979		1030		1046		1153		1171	
3.1(b) Number of PIs at MRC institutes and units (on 1st April)	239		246		357		319		416	
3.2 Number of Research Fellowships (on 1st April)	358		336		348		342		338	
3.3 Number of PIs and CO-Is on research grants (on 1st April) / **the number of Research Organisations** (including Independent Research Organisations)	# of PIs and CO-Is	# of ROs	# of PIs and CO-Is	# of ROs	# of PIs and CO-Is	# of ROs	# of PIs and CO-Is	# of ROs	# of PIs and CO-Is	# of ROs
	2412	367	2581	374	2759	364	3048	394	3275	467

Notes:
3.1(a) This indicator reports the number of Principal Investigators (PIs) supported on research grants on the 1 April of each reporting year. It excludes PIs supported through intramural investments, unless they are in receipt of a research grant. The increase over five years reflects more awards being made by MRC over this period.
3.1(b) As the MRC supports a significant number of researchers at our institutes, university units and units who are not in receipt of a separate research grant or fellowship., we also report these figures in addition to 3.1(a). This is additional MRC-specific data, not part of the harmonised common indicators. Note that 2016/17 includes 88 awards made to the Francis Crick Institute, hence the increase in reported numbers since 2015/16.
3.2 This indicator reports the number of Research Fellows supported on the 1 April of each reporting year.
3.3 This indicator reports the number of PIs and Co-is supported on research grants on the 1 April of each reporting year. It excludes fellows and PIs and Co-Is supported through intramural investments, unless they are in receipt of a research grant. This indicator also includes the number of Research Organisations (including Independent Research Organisations) where these PIs and Co-Is are located. The increase in numbers of PIs/Co-Is and ROs reflects both an increase in number of awards being made but also an increase in Co-Is at international institutions through awards made via the Global Challenges Research Fund (GCRF).

Table 4: Human Capital – postgraduates

Financial Year	2012/13	2013/14	2014/15	2015/16	2016/17
4.1 Number of new doctoral students within that financial year	414	452	387	403	353

Notes:
This indicator denotes the number of MRC-funded PhD students newly registered on the Joint Electronic Submission (Je-S) system within the financial year. Please note that records of MRC studentships on the Je-S database are provided directly by research organisations funded by MRC studentship programmes. These including DTPs and CASE PhD studentships, but may not include all intramural and centre studentships.

Reporting Year	2011/12	2012/13	2013/14	2014/15	2015/16
4.2 Doctoral submission rate ('within expected')	77.7%	92.2%	92.5%	74.2%	77.7%
4.2.1 Submission rate ('outside expected')	14.9%	1.2%	5.0%	24.2%	12.5%
4.2.2 Overall submission rate (total)	92.6%	93.4%	97.5%	98.4%	99.1%
4.2.3 Without submission data[26]	58.8%	49.6%	35.2%	17.6%	22.8%

Notes:
Research councils obtain submission data on students via an annual submission survey completed by the student's host research organisation[27]. Students on research council studentships are encouraged to complete their studies by an expected submission date, although this varies depending on the nature (for example, part/full time) and duration of the studentship undertaken.
At MRC, **expected submission is defined as 'no more than six months after the funding end date'**, where the duration of funding can range from three to four years. However, submission of a thesis can also be affected by career breaks, changes in research direction, changes in supervisory arrangements and other situations outside of the student or research organisation's control. As such the submitting research organisation can adjusted the expected submission date to accommodate such changes. In general, more than 95% of students submit a thesis within one year of their funding end date.

26 Submission data is supplied by research organisations but this information, particularly the verified submission date, is often incomplete. As a result, submissions rates are displayed as a percentage of the total studentships with completed award data, and studentships without submission data are left as 'unknown' until submission information is completed by the research organisation.

27 Records of MRC studentships on the Joint Electronic Submission (Je-S) database are provided directly by research organisations receiving MRC studentship programme funding. See the JeS handbook on PhD submissions for more details. Please note that these data include MRC Advance Course Masters, Doctoral Training Partnerships (DTPs) and CASE PhD studentships, but do not include intramural and limited Centre studentships.

4.3 Destination of Leavers from Higher Education	Academic year programme was completed				
	2011/12	2012/13	2013/14	2014/15	2015/16
4.3.1 of which University	48.5%	55.3%	45.0%	44.7%	39.9%
4.3.2 of which Wider Public Sector	8.0%	3.7%	8.8%	7.2%	6.9%
4.3.4 of which Private Sector	19.0%	20.1%	26.9%	28.0%	31.8%
4.3.5 of which Unknown or Other	18.0%	13.9%	14.4%	13.5%	14.2%
4.3.6 of which Unemployed	6.5%	7.0%	5.0%	6.6%	7.3%

Notes:
Post-submission, the Higher Education Funding Council for England (HEFCE)'s Destinations of Leavers from Higher Education (DLHE) survey provides all research councils with information about all graduates six months after they complete their studies. This survey is a condition of funding for HEFCE-supported higher education institutions (HEIs) in England, which individual HEIs must fund and administer themselves, using materials provided by the Higher Education Statistics Agency (HESA). As such the data provided by HESA to all research councils on their PhD students is limited to those who successfully completed the survey request, so may not account for all studentships in our portfolio.

Table 5: Collaboration, partnerships and secondments

Collaborations, partnerships and secondments	Year the award started									
	2012/13		2013/14		2014/15		2015/16		2016/17	
5.1.1 Instances of collaborations and partnerships reported at point of application and % of awards reporting at least one partner organisation	655	22.4%	661	20.1%	675	30.5%	715	25.5%	718	19%

Collaborations, partnerships and secondments	Year the collaborations, partnerships or secondments were first reported				
	2012	2013	2014	2015	2016
5.1.2 Instances of new collaborations reported in researchfish®	1794	1758	1574	1761	1656
5.2 Instances of secondments reported in researchfish®	94	149	269	289	333

Notes:

5.1.1 This indicator relates to collaborations reported within the research proposal at the point of application. It includes the proportion of awards (expressed as a percentage) reporting at least one partner organisation at the point of application.

5.1.2 This indicator relates to new collaborations as reported within researchfish®. Collaborations are only included in the indicator for the first year that they were reported, but may continue for several years after this date. Researchers may also report collaborations that were in place at the point of application.

5.2 This indicator relates to secondments as reported within researchfish®. Secondments are only included in the indicator for the first year that they were reported, but may continue for several years after this date.

Table 6: Knowledge Generation

Publications	Year outcome realised				
	2012	2013	2014	2015	2016
6.1.1(a). Number of journal articles	12,545	13,654	14,102	14,366	14,125
6.1.1(b). of which unique	9,561	10,551	10,825	11,110	10,981
6.1.2. Number of books	17	29	32	27	29
6.1.3. Number of book chapters	89	147	113	95	72

Publications: Number / proportion of awards	Year the award started									
	2008		2009		2010		2011		2012	
6.1.4 Number / proportion of awards that gave rise to at least one example of a publication within five years of award start date	524	90%	518	90%	440	93%	388	93%	494	92%

Notes:
A publication may have arisen from more than one award. Duplicate publication outputs are removed, where possible, using system-generated codes to indicate when an individual researcher has attributed an output to more than one award. This cannot identify duplicate outputs where different researchers have entered similar information independently of one another. However, the MRC encourages researchers to provide unique identifiers (such as a Digital Object Identifier or a PubMed ID) wherever possible, and works with Researchfish Ltd. and suppliers of bibliometric data to populate unique IDs to all MRC-affiliated publications. As a result, the MRC can also provide an additional total of unique publications for each reporting year (see 6.1.1(b)).

Other outputs	Year outcome realised				
	2012	2013	2014	2015	2016
6.2.1 Instances of artistic and creative outputs	12	19	55	65	71
6.2.2 Instances of research databases and models reported	36	73	101	111	123
6.2.3 Instances of software and technical products reported	18	37	79	85	118
6.2.4 Instances of research tools and methods reported	543	547	737	532	235
6.2.5 Instances of medical products, interventions and clinical trials	137	205	142	96	130

Notes:

6.2.2 Some of the data within researchfish® do not have an associated time stamp. For MRC, there are 442 instances of research databases and models which do not include a time stamp and which are therefore excluded from the common indicators. This represents 42% of the MRC's research databases and models data within researchfish®.

6.2.4 Some of the data within researchfish® do not have an associated time stamp. For MRC, there are 2863 instances of research tools and methods which do not include a time stamp and which are therefore excluded from the common indicators. This represents 34% of the MRC's research tools and methods data within researchfish®.

Intellectual Property (includes patents, copyrights, trademarks)	Year outcome realised				
	2012	2013	2014	2015	2016
6.3 Instances of IP reported (researchfish® data)	125	97	63	66	67

Notes:

This indicator includes patents, copyrights and trademarks. Some of the data within researchfish® do not have an associated time stamp. For MRC, there are 104 instances of intellectual property which do not include a time stamp and which are therefore excluded from the common indicators. This represents 8% of the MRC's intellectual property data within researchfish®.

Spin-outs/start-ups created and significantly supported from the outset	Year outcome realised				
	2012	2013	2014	2015	2016
6.4 Instances of spin-outs / start-ups	13	17	14	12	16

Notes:

Within researchfish®, researchers are asked to provide details of links between their research and the establishment, development or growth of new private sector organisations, including for profit and not-for-profit organisations. Supplemental information was used to identify duplicate spin-out companies where available (for example, Companies House IDs for UK companies).

Table 7: Further Funding

Further Funding: Number / proportion of awards	Year the award started									
	2008		2009		2010		2011		2012	
7.1.1 Number / proportion of awards with at least one instance of further funding within 5 years of the start date	358	62%	374	65%	288	61%	228	55%	297	55%

Notes:
This indicator includes further funding to continue or develop the research, or to support the translation of outcomes into practical application.

Table 8: Engagement activities

Engagement activities: Number / proportion of awards	Year the award started									
	2008		2009		2010		2011		2012	
8.1.1 Number / proportion of awards with at least one instance of engagement within 5 years of the start date	377	65%	362	63%	299	63%	248	59%	343	64%

Notes:
Researchers engage with a wide variety of audiences and stakeholders to communicate research outcomes, disseminate knowledge, stimulate public awareness, and encourage public engagement and dialogue. The engagement activities indicator helps demonstrate the extent to which researchers are engaging with audiences outside academia.

Table 9: Influence on Policy and Practice

Influence on Policy & Practice: Number / proportion of awards	Year the award started									
	2008		2009		2010		2011		2012	
9.1.1 Number / proportion of awards with at least one instance of policy influence within 5 years of the start date	148	26%	155	27%	130	27%	94	23%	134	25%

Notes:
Research may be used to inform policy and practice, which may subsequently lead to wider societal and economic benefit. The influence on policy and practice indicator helps demonstrate the extent to which researchers are informing decision making within government departments and elsewhere.

Medical Research Council
Polaris House
North Star Avenue
Swindon, SN2 1FL