researchfish

MRC Medical Research Council




Outputs, outcomes and impact of MRC research: 2012 report






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Overview

Overview

Researchfish 2012

Researchfish is the system used to collect information on the outputs, outcomes and impacts of MRC-funded research. MRC-funded researchers are asked to record these data all year-round and, once a year, to formally submit this information to the MRC (usually between October and November).

Researchfish, and its predecessor, MRC e-Val, has proved to be an invaluable tool to enhance our understanding of how MRC research improves the health and wellbeing of society through delivering economic, academic and social impact. This information contributes to the evidence we submit to Government in advance of spending reviews and in response to specific questions about the work we fund. The data we collect have also been fundamental in helping us to assess progress against the MRC's Strategic Plan, *Research Changes Lives*[1], which sets out our four strategic aims. Importantly, we also make the data available to universities for use in their REF submissions or any other internal processes or communication activities.

It is important that output data are structured and categorised so that results of interest can be quickly located. This is why Researchfish is organised into 13 sections, dealing with 11 specific output 'types' from research publications and intellectual property to engagement activities and influences on policy. An impact might be reported in several of these sections but with different aspects captured in each. The fact that outputs are easily linked by researchers to one or more of their awards, and awards already linked to principal and co-investigators, means that we can easily pull information together from the point of view of the subject areas, type of output, researcher or research organisation involved.

We collect both quantitative and qualitative information in Researchfish and both types of data are essential to the MRC's evaluation programme and used widely across the MRC. Counts of outputs reported are used to broadly track the growth of the Researchfish dataset, and quickly identify areas of the portfolio that report a higher or lower volume of output from the average, or from awards in comparable schemes or subject areas. The qualitative information attached to outputs enables us to convey and assess the impact of research and is used extensively in external and internal communication, from case-studies on the MRC's website to reports to Government. Our aim is that this summary helps to convey in numbers and narrative, the variety, progress, and significant impact delivered by MRC research.

The data collected through Researchfish are published on the RCUK Gateway to Research[2]. The Gateway to Research aims to make available information about what all seven research councils are funding and the outputs that have arisen from this work. The MRC expects that the public availability of Researchfish data will help continue to encourage accurate and complete reporting within Researchfish.

The MRC requires researchers to submit information annually via Researchfish through the life-time of the award and for at least five years afterwards. The MRC relies upon this account as the primary feedback from researchers about the progress, productivity and quality of their work. The compliance policy can be found on our website[3]. It should be noted that the

data reported via Researchfish do not currently feed into the peer review process. However we are actively looking at ways for researchers to be able to more widely re-use their Researchfish data, for example, in CVs and grant applications.

Further information on the principles we follow on the collection, use and analysis of Researchfish data can be found on our website[4].

In the 2012 data-gathering period, the MRC Researchfish dataset grew to 150,000 reports of output, and this summary evidences the diversity of these reports and the detail that researchers provided. The MRC would like to thank the 3,500 researchers, as well as their colleagues, including university support offices and unit/institute administrators who updated, edited and checked the data entered into Researchfish.

Researchers told us about more than 43,000 unique publications that had arisen from MRC-funded research, including 319 papers in *Nature* and 316 papers in *The Lancet*. **Professor Charles Swanton (University College London Hospital)** reported a paper[5] published in the *New England Journal of Medicine* that provided evidence of intratumour heterogeneity, potentially having important consequences for personalised-medicine approaches. This paper achieved a staggering normalised citation index (NCI) of 173 times the world average in less than a year. The work was funded by the MRC and also Cancer Research UK, the Royal Marsden Hospital Renal Research Fund, Novartis, the European Commission, and the Wellcome Trust. Links between MRC awards and publications, reported via Researchfish, are now transferred automatically[6] to Europe PubMed Central[7] the leading open access repository of biomedical publication information.

More than half of respondents (61 per cent) reported that their work had been supported by collaborations between 2006 and 2012. These collaborations can be extensive, for example, **Professor Simon Gayther**, who moved from UCL to the University of Southern California in 2010, reported that he had been a part of the Collaborative Oncological Gene-environment Study (COGS)[8]. This is an international consortium substantially funded by the European Commission bringing together 160 groups studying the genetic and environmental risk factors associated with breast, prostate and ovarian cancer. COGS includes many UK cancer research groups, some of which are funded in part by the MRC. In 2013, this study reported that its combined efforts had revealed more than 80 genetic 'spelling mistakes' that increased the risk of these cancers, following analysis of the genome of 100,000 cancer patients. The results were released in five papers published in a special edition of the journal *Nature Genetics* as well as seven other simultaneously published papers in other journals.

Almost half of MRC-funded researchers (48 per cent) reported receiving further funding, £2.3 billion in total between 2006 and 2012, from almost 1,000 different funders. £90m (four per cent) of this was from the private sector, including £1m from AstraZeneca to **Dr Christina Davies (MRC Clinical Trial Studies Unit)** for her international Adjuvant Tamoxifen: Longer Against Shorter (ATLAS) study. ATLAS reported in 2013 that the benefits of continuing Tamoxifen treatment for ten years as opposed to five outweighed the risks[9].

There were almost 7,000 reports of staff moving from MRC support between 2006 and 2012; the majority were researchers, post-doctoral researchers and research fellows, leaving to pursue roles in a natural career progression. Over time we expect to discover more about the flow of skilled people from MRC support to other sectors.

Researchers reported over 18,000 engagement activities having taken place between 2006 and 2012. These included academic papers receiving substantial media attention, such as: **Dr Aylwyn Scally's (Wellcome Trust Sanger Institute)** report detailing the mapping of the gorilla genome (an extensive collaboration between more than 20 groups

funded from many sources including the MRC); talks, for example, **Dr Kristien Boelaert's (University of Birmingham)** presentation to nurses on updated guidance for the management of hyperthyroidism; and schemes to support engagement activities, such as the Royal Society scientist/MP pairing scheme.

There were over 3,000 examples of influences on policy reported between 2006 and 2012. These included citations in clinical guidelines, such as **Dr Andrew Nunn's (MRC Clinical Trials Unit)** work in the development of new WHO guidelines on the treatment of tuberculosis, and influences on practice, such as **Professor Henry Houlden's (University College London)** research, which has led to the first experimental treatment for a childhood motor neuron disease[10].

Recipients of almost half (46 per cent) of MRC awards reported that their work had produced research materials for others to use. This tangible knowledge exchange included new genetic resources such as **Dr Oliver Billker's (MRC Senior Research Fellow at the Wellcome Trust Sanger Institute)** PlasmoGEM, which converts genomic libraries into gene targeting vectors, and new cell lines, for example, **Professor Alastair Sloan's (Cardiff University)** development of a human dental pulp stem cell line, which has negated the need for dental cell isolation from animals.

There are 869 reports of intellectual property having been generated as a result of MRC-funded research, including a number of patents from the MRC/Cambridge Centre for Stem Cell Biology and Regenerative Medicine, **Dr Emma Blain's (Cardiff University)** research on the use of frankincense as an anti-inflammatory treatment in osteoarthritis funded via the MRC Developmental Pathway Funding Scheme, and **Dr Rebecca Fitzgerald's (MRC Cancer Cell Unit)** invention of the 'Cytosponge', an innovative new approach for the early diagnosis of oesophageal cancer.

Recipients of 10 per cent of awards reported that their research had led to the development of a new product or intervention. MRC research that established monoclonal antibodies as a new therapeutic intervention in the 1980s is now relied upon by a global industry worth more than $40bn a year. Other products brought into use in a much shorter timescale (since 2006) include the use of smartphone applications for processes such as antibiotic prescribing, as reported by **Professor Jon Friedland (Imperial College London)**, new diagnostic tests, such as a blood test for the presence of prion infection led by **Dr Graham Jackson (MRC Prion Unit)**, and new technologies, for example, acousto-optic laser microscopy, a high-speed 3D optical imaging technology, at **Professor Angus Silver's (University College London)** laboratory.

The MRC now has evidence of MRC-supported research having led to the creation or growth of 104 companies, 56 of which have been formed since 2006. These include **Heptares Therapeutics Ltd**, formed in 2007 with intellectual property from the MRC's Laboratory of Molecular Biology and the National Institute of Medical Research, which has generated £30m of new venture capital and employs 70 staff, and **Oxford Nanopore Technologies**, formed as an Oxford University spin out in 2005, and which in 2012 unveiled a prototype DNA sequencer which aims to conduct whole-genome sequencing at a cost of less than $1,000 for the first time. Overall there is evidence for these companies creating at least 500 new skilled jobs in the UK.

Recipients of 50 per cent of awards reported that their work had resulted in a form of recognition for themselves or for members of their MRC-funded team that warranted reporting in Researchfish. These included being invited to speak at a conference, being appointed to the editorial board of a journal, and being awarded a research prize, such as **Professor Kathryn Maitland (Imperial College London)**, who was awarded the 2012 British Medical Journal (BMJ) research paper

of the year for her paper on the Fluid Expansion as Supportive Therapy Trial (FEAST), **Dr Jason Chin (MRC Laboratory of Molecular Biology)**, awarded the Louis-Jeantet Young Investigator Career Award in 2011 for his ground-breaking work in synthetic biology and **Professor John Hardy (University College London)**, who was awarded the IFRAD European Grand Prize for Alzheimer's research in 2011 for his work in identifying the biological cascade of Alzheimer's disease.

Further examples of all eleven output types can be found through the pages of this report, as well as information about the associated impact where reported.

The availability of these data has helped transform the MRC's ability to demonstrate delivery against its strategic plan. The main step change in evaluation has been moving from being able to describe activity (in terms of spend/investment in specific areas) to being able to track outcomes from these investments.

2012 data-gathering statistics

The fourth annual MRC data-gathering period in 2012 – the first using Researchfish – saw a 97 per cent compliance rate with 4,273 responses out of a potential 4,407.

Half of the awards submitting information to Researchfish (44 per cent) started in the years 2006-2010 inclusive. The distribution of the start dates of these awards is shown in figure 1.

The majority of awards reporting outputs via Researchfish were research grants (65 per cent), followed by fellowships (19 per cent). The distribution of types of grants is shown in figure 2.

Figure 1: Distribution of the start dates of awards submitting information to Researchfish.

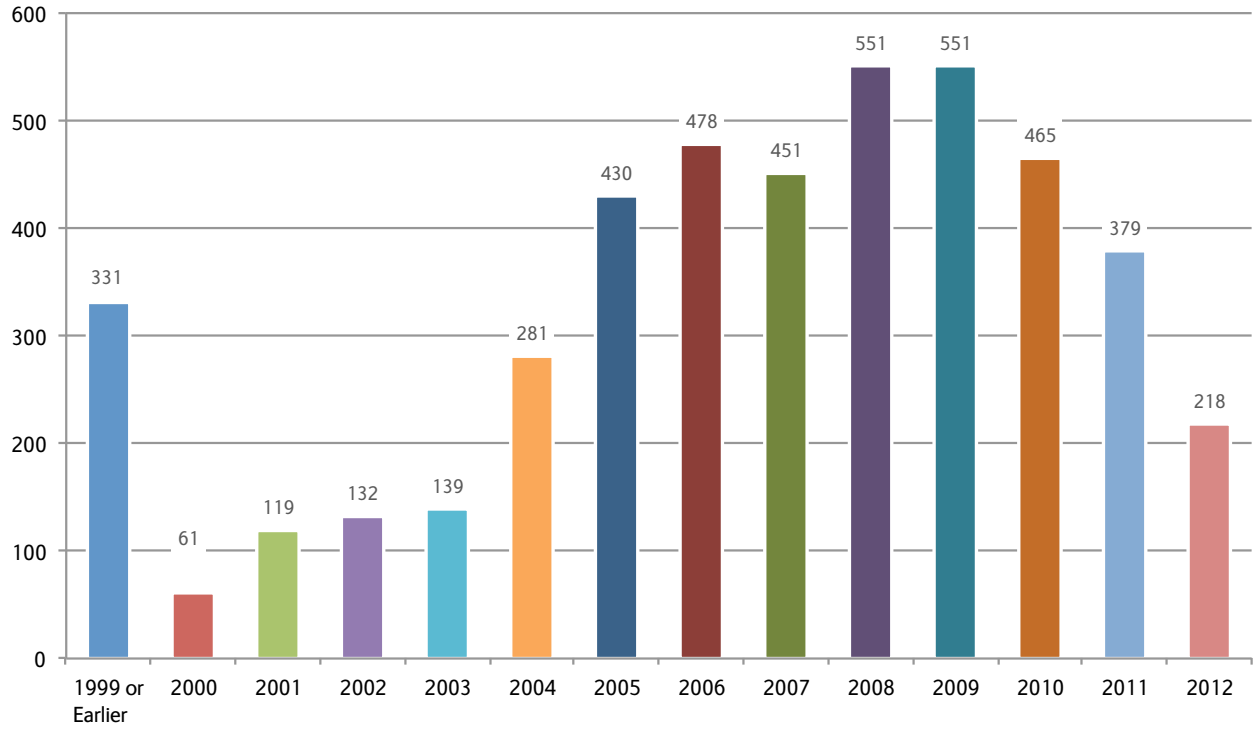
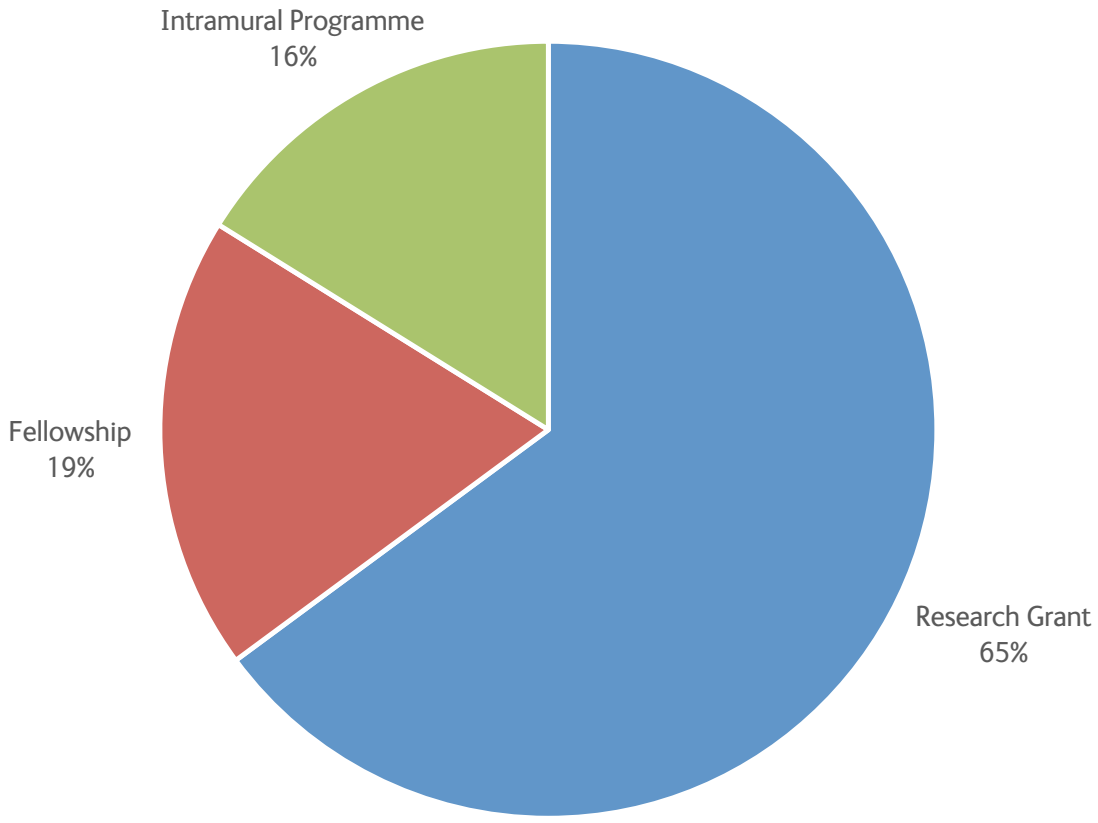


Figure 2: Distribution of types of grants reporting outputs



History of Researchfish

Researchfish originated as MRC e-Val, which was launched in November 2009. The MRC received data on 83 per cent (2,533 returns) of the grants, fellowships and unit research programmes that we sought information on. Following two further successful data-gathering periods in 2010 and 2011, when the response rate increased to 91 per cent and 98 per cent respectively, other organisations funding research expressed an interest in using the system. After working with these funders on a 'federated' version of e-Val, the resulting system, Researchfish, was launched in 2012.

Researchfish now works across funders so that researchers only need to enter an output once and can then associate it to the relevant funder or funders. The system is also more streamlined so that it is easier for researchers to enter data on their outputs and outcomes.

As of August 2013, there are approximately 80 research organisations and funders using Researchfish, including 54 medical research charities and 11 universities[11].

The Science and Technology Facilities Council has successfully implemented Researchfish[12], and work is underway to extend the approach to other research disciplines.

For any queries related to the content of this report, please contact the Evaluation Team at evaluation@headoffice.mrc.ac.uk

Endnotes

1. http://www.mrc.ac.uk/Newspublications/Publications/Strategicplan/index.htm
2. http://gtr.rcuk.ac.uk/
3. http://www.mrc.ac.uk/Achievementsimpact/Outputsoutcomes/e-Val/collection_compliance/index.htm
4. http://www.mrc.ac.uk/Achievementsimpact/Outputsoutcomes/e-Val/MRCe-Val-Principlesofuse/index.htm
5. Intratumor heterogeneity and branched evolution revealed by multiregion sequencing N Engl J Med 2012; 366:883-892 March 8, 2012DOI: 10.1056/NEJMoa1113205:
6. Public to see impact of medical research funding *EuroLab* (2013)
7. http://www.scientistlive.com/content/public-see-impact-medical-research-funding
8. http://europepmc.org/
9. http://www.cogseu.org/index.php/short-description-of-cogs
10. Long-term effects of continuing adjuvant tamoxifen to 10 years versus stopping at 5 years after diagnosis of oestrogen receptor-positive breast cancer: ATLAS, a randomised trial *The Lancet*, Volume 381, Issue 9869, Pages 805 – 816 (2013) www.thelancet.com/journals/lancet/article/PIIS0140-6736(12)61963-1/abstract
11. Exome sequencing reveals riboflavin transporter mutations as a cause of motor neuron disease *Brain* (2012) http://brain.oxfordjournals.org/content/early/2012/06/26/brain.aws161.short?rss=1 An up to date list of organisations using Researchfish can be found at https://www.researchfish.com/ourmembers
12. http://www.stfc.ac.uk/1846.aspx

researchfish

MRC Medical Research Council

Outputs, outcomes and impact of MRC research: 2012 report

01: Publications

Publications

Summary

In this section, we discuss feedback received on the publication output from MRC-funded research. Original scientific research published for the first time in peer-reviewed journals is an important primary output from research, and an integral part of the scientific method. The function of journal publications – to communicate this information, build a collective knowledge base, validate the quality of research, influence the distribution of rewards and build scientific communities – has remained unchanged for hundreds of years despite innovations in publishing and new models for accessing this information[1,2]. While we also capture information about secondary publications such as systematic reviews, editorials and other types of literature such as conference proceedings and books via Researchfish, this section focuses mainly on analysis of publications categorised by Thompson Reuters as 'journal articles' and 'journal reviews'.

There is a large amount of interest, from across the research community, in measuring the impact of particular articles in journal literature, and the extent to which this knowledge is used. By using data from the Thompson ISI Web of Science database[3] we can examine how a larger body of international research literature cites MRC publications.

- 83 per cent of MRC awards have at least one report of a paper; the majority of awards with no published output are recently started.
- There were 60,233 reports of publications in Researchfish, of which 43,329 are unique publications.
- The average number of publications reported for each award generating at least one publication was 15.
- 20 per cent of all awards generated more than 16 publications, with 65 awards each reporting more than 100 publications.
- The citation impact of MRC publications, as measured by the Thompson Reuters 'normalised citation impact' score, remains more than twice the world average.

MRC papers reported in Researchfish

Researchers are asked to record publications in Researchfish that, in their view, resulted wholly or in part from MRC support. The number of publications is monitored so that the growth of the Researchfish dataset can be tracked, and this is greatly enhanced by the information we obtain on the subsequent impact of articles.

In the MRC Researchfish dataset, there are now over 60,233 reports of publications arising from MRC-funded research. This consists of 43,329 unique publications, as some are reported by more than one researcher.

Researchfish allows principal investigators to enter publications by copying and pasting up to 200 PubMed IDs at a time; the system then returns the basic bibliographic reference for each paper (for example, title, first author, journal, publication date). Researchfish also includes a link to the PubMed[4] website, so researchers can quickly and easily look up and enter

details of their publications. PubMed is an extensive and well-regarded bibliographic database of the abstracts of published biomedical research papers set up by the US National Institutes of Health (NIH) and includes the majority of abstracted articles and reviews relevant to medical research.

In 2013 the Researchfish system was linked with Europe PubMed Central (Europe PMC)[5]. Europe PMC is a free digital archive of biomedical and life sciences literature set up by a consortium of leading European research funders in 2007. Funders include the Wellcome Trust, MRC, Cancer Research UK and the European Research Council. A full list of funders can be found on the Europe PMC website[6]. Europe PMC provides a stable, permanent and free-to-access online digital archive of full-text, peer-reviewed research publications, based on PubMed. If MRC-funded papers are included in Europe PMC and MRC funding acknowledged[7], then these records are transferred to Researchfish. Records of papers entered into Researchfish and attributed against specific MRC (or other funder) awards are transferred to Europe PMC where they augment the publicly displayed information on funding sources that contributed to that publication.

For journals not abstracted by PubMed, researchers are asked to provide brief bibliographic details, for example, first author, title and journal, so that these outputs can also be recorded. In the near future, Researchfish will include a lookup for digital object identifiers (DOI) to widen the literature for which standard bibliographic information can be obtained.

After the Researchfish data gathering period, bibliographic details of unique papers were provided to Thomson Reuters[8] who returned citation information for every publication they could match to the Thomson ISI Web of Science database. Whilst the ISI database does not include all journals in which MRC researchers publish, citation data were returned for around 94 per cent of the papers sent for analysis (48,643/51,896[9]). Table 1 and figure 1 show the number of publications for each year since 2006. (Where a publication does not have a normalised citation impact (NCI)[10], this is shown.)

Figure 2 shows the number of awards starting in each year from 2005 to 2012 for which at least one publication is reported (blue) and the number for which no papers have been reported (red). While the overall proportion of awards reporting at least one paper is 83 per cent, this is clearly in part a function of time. Around 90 per cent of awards starting in 2006 have produced a paper (433/478), whereas 70 per cent of awards (268/379) starting in 2011 have reached the stage of reporting a paper. These results are similar to a recent analysis of 2.5 million papers from grants awarded by the US National Institutes of Health over 30 years. This showed that 75 per cent of projects produced a paper within three years, and 95 per cent within five years[11].

Table 1: Number of articles and reviews published each year

	2006	2007	2008	2009	2010	2011	2012	Total
NCI	4,376	5,313	5,969	6,843	7,453	7,732	6,668	44,354
No NCI	21	25	23	39	60	62	412	642
Total	**4,397**	**5,338**	**5,992**	**6,882**	**7,513**	**7,794**	**7,080**	**44,996**

Figure 1: Number of articles and reviews published each year

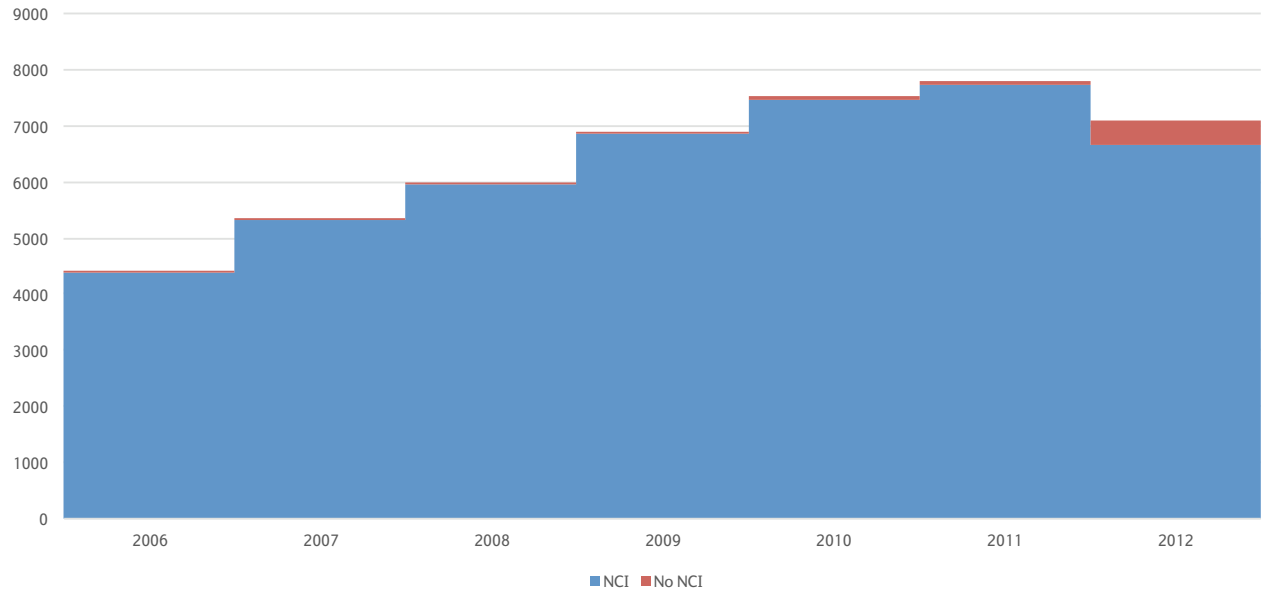
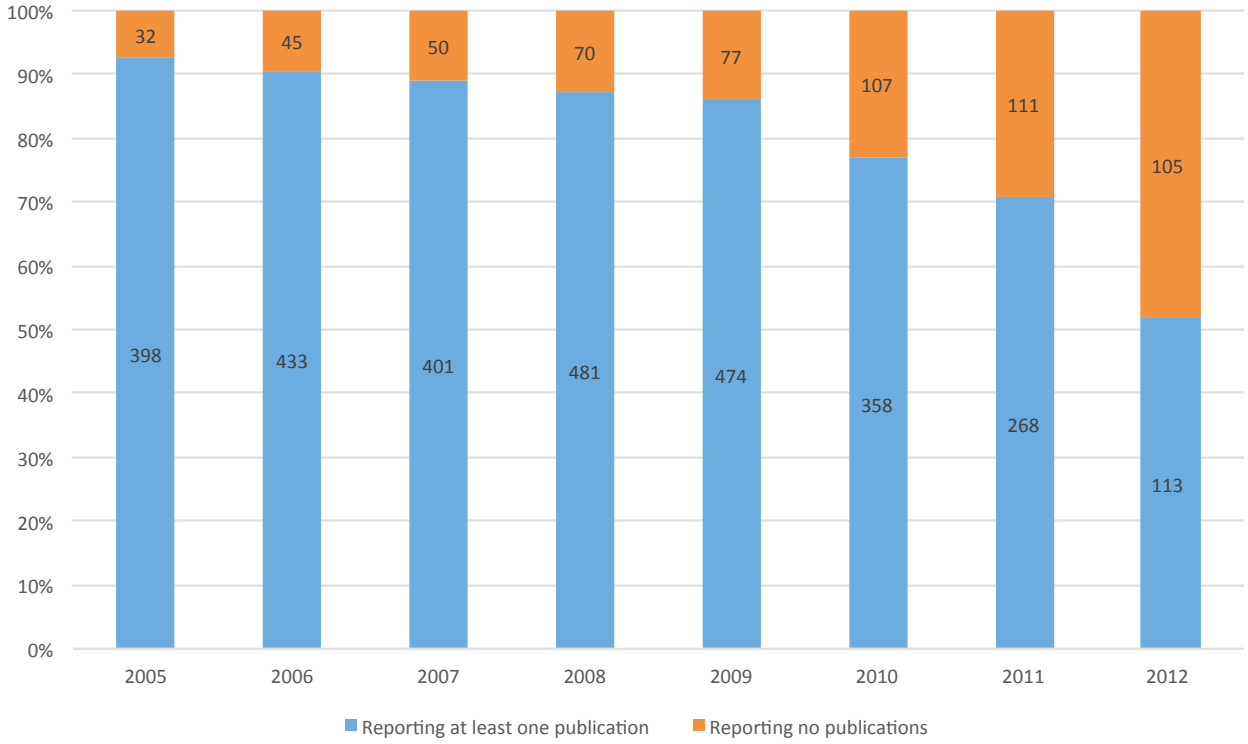


Figure 2: Numbers of awards initiated in each year 2005 - 2012 reporting at least one publication by 2012



Journals in which MRC researchers have published most frequently 2006-2011

PLOS One is the journal in which MRC researchers have published most frequently[12] (1,168 papers, 2.4 per cent of total output), followed by *Proceedings of the National Academy of Sciences of the United States of America* (751 papers, 1.5 per cent of total output) and *Journal of Biological Chemistry* (671 papers). Table 2 shows the 20 journals that MRC researchers have published in most frequently.

Table 2: Journals in which MRC researchers have published most frequently

Journal title	Number of papers
PLOS one	1,168
Proceedings of the National Academy of Sciences of the United States of America	751
Journal of Biological Chemistry	671
Journal of Neuroscience	462
Journal of Immunology	437
Neuroimage	408
Blood	397
British Medical Journal	370
Journal of Virology	358

Nature	319
Human Molecular Genetics	319
Lancet	316
Brain	306
Nature Genetics	301
Development	254
Nucleic Acids Research	232
Science	229
Journal of Molecular Biology	226
Neurology	203
AIDS	203

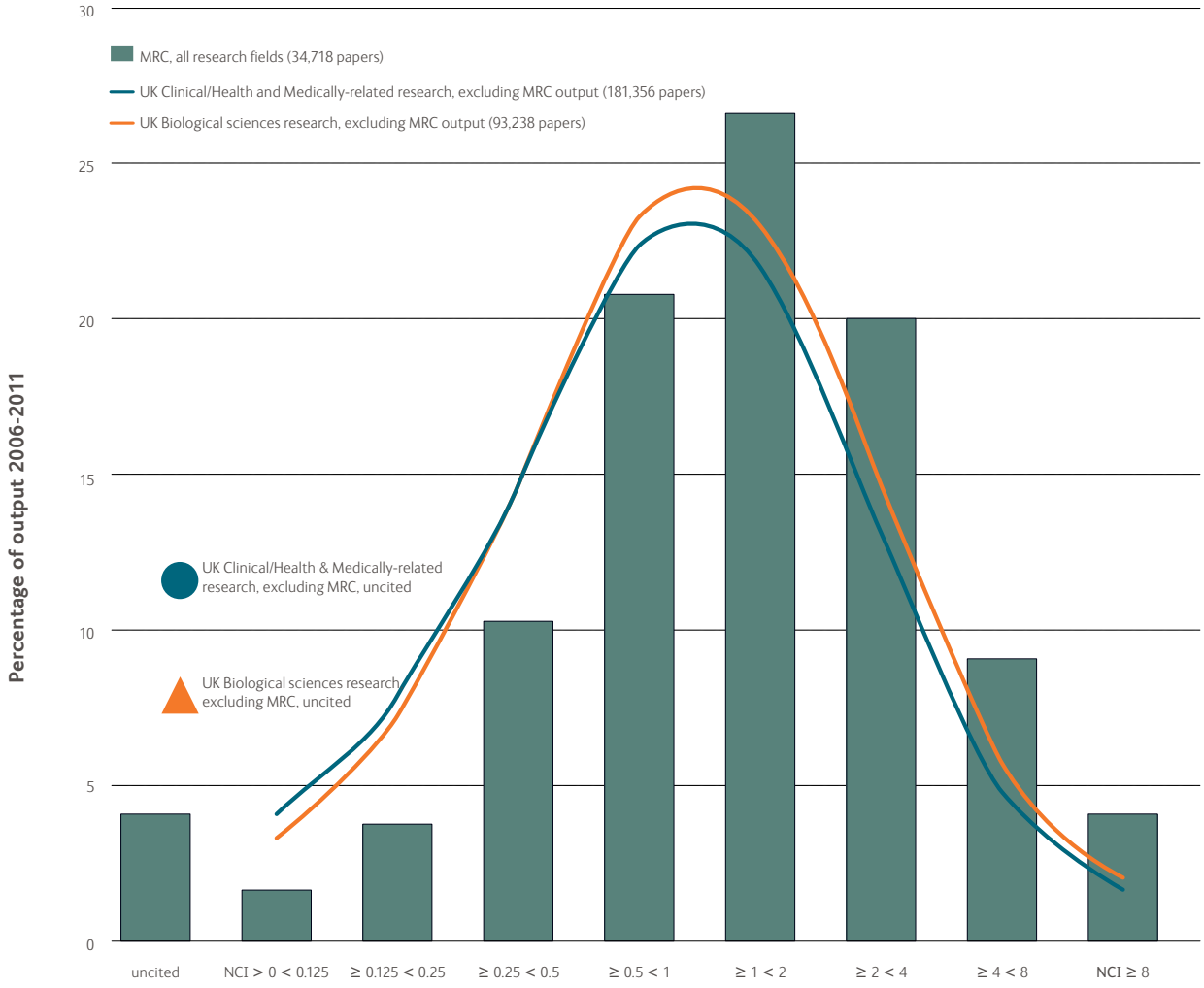
Citation impact of MRC papers

The citation of publications in further peer-reviewed research articles is often used as a proxy measure of academic and wider user impact. Citation counts can be normalised by scientific field and year of publication which gives a normalised citation impact (NCI). The type of publication will influence the citation count and so only citation counts from reviews and articles are used in calculations of citation impact. An NCI score of 1 means that the paper is behaving as would be expected for that subject area in that year, and this is referred to as the world average, so an NCI of above 1 means that the paper is cited more than would be expected. A further measure of quality of publications is the number/percentage of articles that are either uncited or conversely those deemed as highly cited (ie with an NCI score that is greater than or equal to 4)[13]. Having assessed several measures of citation impact and metrics such as the 'h index' and its variants, we consider the NCI score to be the most consistent and robust bibliometric measure available, although the limitations of purely citation-based measures should be noted. For example the Thompson Reuters NCI is not designed to capture the use of a publication outside of scholarly literature. There is evidence that scholars are increasingly moving their everyday work to the web[14] (online reference managers Zotero[15] and Mendeley[16] each claim to store over 40 million articles) which highlights the need for tools to capture the extent to which papers are downloaded from a wide range of repositories, and there is growing interest in monitoring discussion of papers via social media and other networks[17]. We intend to assess these alternative measures of the use of published knowledge as they mature.

The average NCI across all MRC papers published between 2006 and 2011 is 2.12[18]. This is higher than both the NCI for papers generated by other UK clinical/health and medically-related research (excluding MRC output) and by UK biological sciences research (excluding MRC output) which are 1.34 and 1.44 respectively.

Figure 3 shows an Impact Profile® of MRC publications between 2006 and 2011. This enables an examination and analysis of the balance of MRC publications relative to world average and in comparison to publications generated by other UK medically-related and biological sciences research. It shows the proportion of uncited papers and the proportion in each of the eight categories of relative citation rates, normalised to world average.

Figure 3: Impact Profile ® of MRC publications between 2006 and 2011



Data & analysis: Thomson Reuters (Evidence)

MRC-funded research also generates a greater percentage of highly-cited papers than other UK clinical/health and medically-related research and UK biological sciences research (13 per cent compared to 5.9 and 6.7 per cent respectively).

Only four per cent of 2006-2011 MRC papers remain uncited, compared to 12 per cent of UK medically-related papers (excluding MRC output) and eight per cent of UK biological sciences papers (excluding MRC output).

Figure 4 is a box plot and whiskers diagram showing the distribution of average NCI by year. The inclusion of the second and third quartiles of data and the interquartile mean for each year allows us to determine whether or not the average NCI is skewed by anomalies in any year. In this case, it confirms that the distribution of NCI data is consistent across the years. This representation of the data is particularly useful for comparing distributions and showing differences which are not always easily apparent in an Impact Profile® plot.

Table 3 shows the distribution of NCI for the top 20 subject areas (by number of publications)[19].

Figure 4: Distribution of average NCI by year

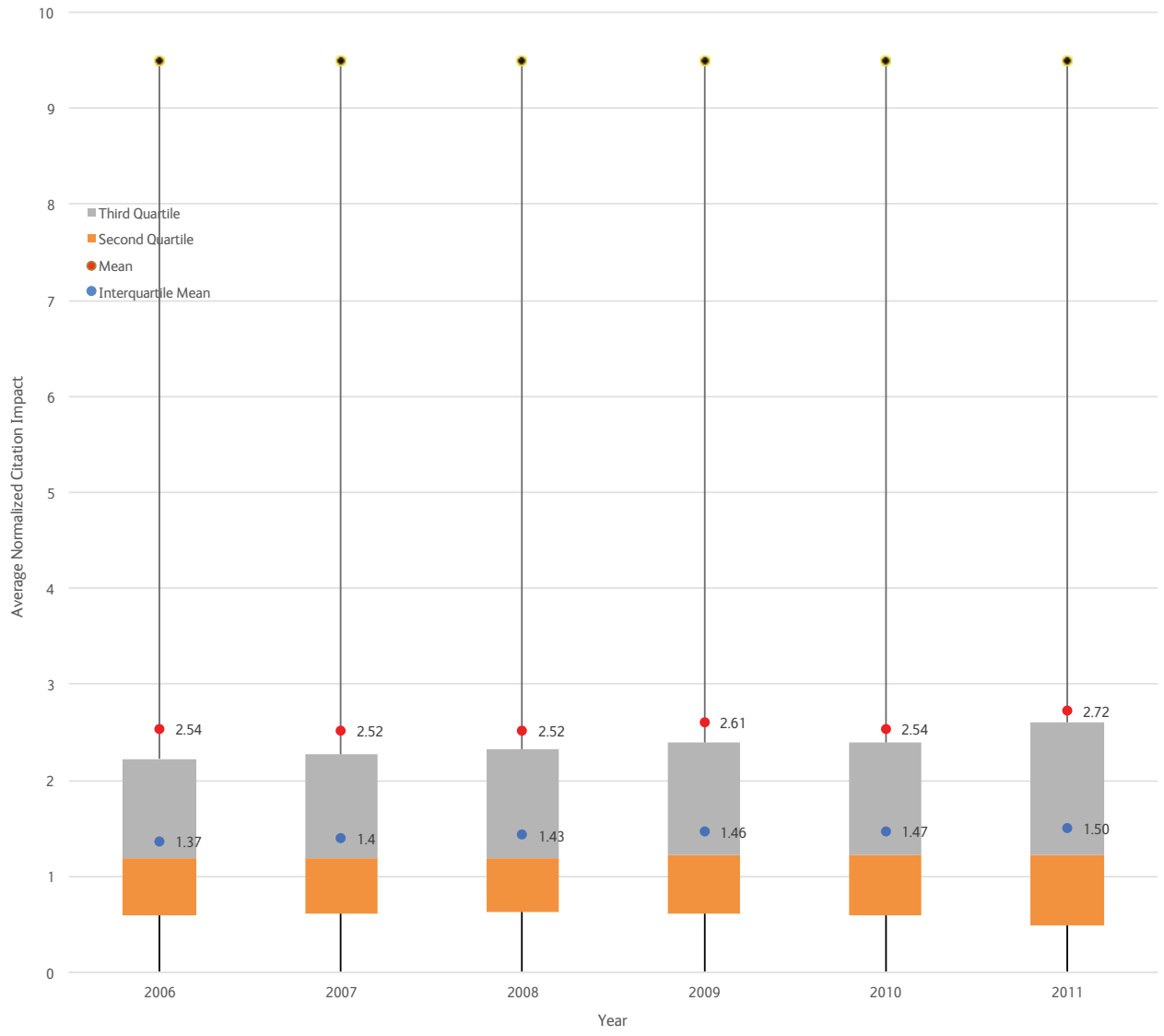


Table 3: Distribution of NCI for the top 20 subject areas (by number of publications)

Subject	Total Number	Mean	NCI 1 or more	NCI 4 or More	NCI 8 or More
Biochemistry & Molecular Biology	4767	1.913473	53%	10%	3%
Neurosciences	4202	1.887894	56%	10%	3%
Cell Biology	2782	1.696836	52%	8%	2%
Immunology	2249	1.99611	53%	11%	4%
Genetics & Heredity	2128	2.704648	56%	16%	7%
Clinical Neurology	1733	2.520547	64%	16%	5%
Public, Environmental & Occupational Health	1595	2.12464	56%	12%	3%
Psychiatry	1459	2.339709	64%	14%	4%
Endocrinology & Metabolism	1448	1.716378	52%	8%	2%
Oncology	1340	2.005404	52%	9%	3%

Virology	1048	1.752366	54%	8%	2%
Infectious Diseases	879	1.713844	52%	8%	2%
Developmental Biology	860	1.412134	47%	6%	1%
Pharmacology & Pharmacy	842	2.090854	60%	12%	3%
Microbiology	800	1.994435	63%	11%	3%
Radiology, Nuclear Medicine & Medical Imaging	776	2.153271	64%	12%	2%
Biotechnology & Applied Microbiology	771	2.112354	54%	11%	3%
Haematology	768	1.898522	60%	9%	2%
Biophysics	690	1.999376	48%	9%	2%

The top five MRC publications by NCI between 2006 and 2011[20]

Intratumor heterogeneity and branched evolution revealed by multi-region sequencing

(*N Engl J Med* 2012; 366:883-892 March 8, 2012 DOI: 10.1056/NEJMoa1113205): NCI – 173

With rare exceptions, spontaneous tumors originate from a single cell. Yet, at the time of clinical diagnosis, the majority of human tumors display startling heterogeneity in many morphological and physiological features, such as expression of cell surface receptors.

This paper summarises the result of a study that used multi-region genetic analysis to provide evidence of intratumor heterogeneity in four consecutive tumours.

Genetic intratumor heterogeneity can contribute to treatment failure and drug resistance. Intratumor heterogeneity may have important consequences for personalised-medicine approaches that commonly rely on single tumor-biopsy samples to portray tumour mutational landscapes.

The work was reported by **Professor Charles Swanton** (University College London Hospital) and funded by the MRC, Cancer Research UK, the Royal Marsden Hospital Renal Research Fund, Novartis, the European Commission, and the Wellcome Trust.

Adenovirus-associated virus vector-mediated gene transfer in hemophilia B

(*N Engl J Med* 2011; 365:2357-2365 December 22, 2011 DOI: 10.1056/NEJMoa1108046): NCI – 87

This paper presents the results of phase 1 and 2 clinical trials involving virus-mediated gene transfer as a treatment for haemophilia B. Unlike previous gene transfer treatments, which show only transient expression of FIX, the protein critical for blood clotting, this study used self-complementary adenovirus-associated vectors, which mediate transgene expression at substantially higher levels than do single-stranded adenovirus-associated vectors.

The authors state that the approach "has the potential to convert the severe bleeding phenotype into a mild form of the disease or to reverse it entirely"[21]. The work was funded by NIHR, the MRC, the Katharine Dormandy Trust, the UK Department of Health, NHS Blood and Transplant and others.

Effects of bariatric surgery on mortality in Swedish obese subjects

(*N Engl J Med* 2007; 357:741-752 August 23, 2007 DOI: 10.1056/NEJMoa066254): NCI – 87

This paper presented the results of a prospective study of over 4,000 obese patients, half of whom received bariatric surgery and half who received conventional lifestyle interventions. The Swedish Obesity Survey followed these patients for 10 years. The results showed that bariatric surgery was associated with long-term weight loss and decreased overall mortality compared to the matched group of patients that did not receive surgery. The paper provided evidence that bariatric surgery could be considered as a favourable option for tackling obesity and this continues to be an issue of significant interest. The **MRC Human Nutrition Research Unit** in Cambridge was acknowledged in this paper and one of the lead authors was at the time a senior scientist at the unit.

A phase 3 trial of bevacizumab in ovarian cancer

(*N Engl J Med* 2011; 365:2484-2496 December 29, 2011 DOI:10.1056/NEJMoa1103799): NCI – 83

This paper presents the results of a phase 3 clinical trial (ICON7[22]) of over 1,500 women with ovarian cancer (either high-risk early stage or advanced stage disease) led by the **MRC's Clinical Trials Unit** at UCL and funded by Roche and others. The women were given either two-drug chemotherapy or two-drug chemotherapy plus bevacizumab. Results showed that the use of bevacizumab given concurrently with five or six cycles of platinum-based chemotherapy and continued for an additional 12 cycles improved progression-free survival by about 2 months and increased the response rate by 20%. The progression-free survival and overall survival benefits were much greater among the patients at high risk for progression.

Long-term effect of aspirin on cancer risk in carriers of hereditary colorectal cancer: an analysis from the CAPP2 randomised controlled trial

(*The Lancet*, Volume 378, Issue 9809, Pages 2081 - 2087, 17 December 2011 DOI:10.1016/S0140-6736(11)61049-0): NCI – 68

This paper presented the results of a long-term follow up to the MRC-funded CAPP2 randomised controlled trial which looked at the effects on the inhibition of the development of malignant cells of aspirin and a resistant starch in carriers of Lynch syndrome, the major form of hereditary colorectal cancer. This paper was reported by the lead investigator on the trial, **Professor Sir John Burn** (Newcastle University), and also co-authors **Professor John Mathers** (Newcastle University) and **Professor Malcolm Dunlop** at the **MRC's Human Genetics Unit** at the University of Edinburgh. In addition to the MRC, the work was funded by the European Union, Cancer Research UK, Bayer Corporation, National Starch and Chemical Co, Newcastle Hospitals trustees, Cancer Council of Victoria Australia, THRIPP South Africa, The Finnish Cancer Foundation, SIAK Switzerland and Bayer Pharma.

Carriers of Lynch syndrome were randomly assigned in a two-by-two factorial design to 600 mg aspirin or aspirin placebo or 30 g resistant starch or starch placebo, for up to four years. Findings supported the hypothesis of a delayed effect of aspirin on colorectal cancer by showing that aspirin substantially reduced incidence of colorectal cancer with the effect becoming apparent after three to four years from the start of aspirin intervention, a difference consistent with faster cancer development in those with Lynch syndrome. Cancer Research UK have funded the £1.4m CAPP3 study to determine the optimum dose and duration of treatment with asprin and this work is expected to start in 2014.

MRC papers published in 2012 already exhibiting high citation impact

The bibliometric analysis here includes papers published between 2006 and 2011 and in the Thompson Reuters database, and citation is taken at the end of 2012 so that all papers had at least one year to accumulate citations. There are papers published at the end of 2011 and during 2012 (which are entered into the Thompson Reuters 2012 database) that have already rapidly been cited, and are likely to feature in next year's highly cited list. Overleaf are three that are already being cited at a rate that is more than 40 times the world average.

Consideration needs to be given to the different rates at which citation scores build up for different types of publications. Short or rapid publications (such as letters) may have a greater 'immediacy'[23], but may also have a shorter cited 'half-life'[24]. On the other hand, a full paper will usually have a citation peak around three years after publication, and therefore a lower immediacy. It will also have a gentler decline after its peak, and consequently a longer cited half-life[25]. Occasionally papers may exhibit a 'slow burn/quick ignition' phenotype, attracting little interest soon after publication, but gradually (or even suddenly) achieving high citation rates as the work gains wider relevance and recognition.

Galectin 8 targets damaged vesicles for autophagy to defend cells against bacterial invasion

(*Nature* 2012 Jan 15; 482(7385):414-8. doi: 10.1038/nature10744): NCI – 46

Autophagy, cell degradation, defends mammalian cells against bacterial infection. This study, led by **Dr Felix Randow** at the **MRC's Laboratory of Molecular Biology** (LMB), demonstrates that galectin-8 is a receptor for vesicle-damaging pathogens, such as *Salmonella*[26].

Short frontal lobe connections of the human brain

(*Cortex* 2012 Feb;48(2):273-91. doi: 10.1016/j.cortex.2011.12.001. Epub 2011 Dec 13): NCI – 42

The frontal lobe of the brain has been shown to play a role in attention and memory, executive cognition, social behaviour and consciousness. This study mapped the architecture of the short frontal lobe tracts in the human brain, the anatomy and the functional correlates of short frontal fibres being largely unknown in man. The preliminary findings can be used as a framework for understanding the anatomy of these connections in larger groups of subjects and to correlate their anatomy with cognitive and behavioural performances in healthy populations and those with brain disorders.

The work was funded by Guy's and St Thomas Charity, the Wellcome Trust, the Marie Curie Intra-European Fellowships for career development (FP7) and the Agence Nationale de la Recherche (ANR). The specimens the study relied upon were provided by the Newcastle Brain Tissue Resource, which is funded by the MRC and NIHR.

Vandetanib in patients with locally advanced or metastatic medullary thyroid cancer: a randomized, double-blind phase III trial

(*J Clin Oncol*) 2012 Jan 10;30(2):134-41. doi: 10.1200/JCO.2011.35.5040. Epub 2011 Oct 24): NCI – 40

There is no effective therapy for patients with advanced medullary thyroid carcinoma (MTC). This paper presents the finding of a phase 3 clinical trial of the use of vandetanib. 331 patients were randomly assigned to receive vandetanib (231) or placebo (100).

Patients who received vandetanib had a longer period of survival without disease progression (median approximately 11 months) compared with those receiving the placebo. The disease control rate and biochemical response in the treatment group was also improved compared to that of the control group.

This study was predominantly funded by AstraZeneca and reported by **Dr Anderson Ryan** of the **MRC-CRUK Gray Institute for Radiation Oncology and Biology**, who was one of the paper's authors.

Co-authorship

Co-authorship of publications provides an insight into the patterns of research collaboration. Co-authorship data can indicate the variety and even duration of collaborations. If a wider collection of publication data is available, then connections across the scientific community can be examined, and this can be used to represent networks of interactions between scientists.

- The average number of authors per paper, as reported in Researchfish was eight.
- 93 per cent of publications (41,050) had at least one academic author and seven per cent had at least one private sector author (3,092).
- Discounting the UK, the highest number of co-authors reported on MRC publications (28,356) were based in the USA, followed by Germany (9,281) and France (6,673).

Figure 5 shows the distribution of co-authors by sector across the whole MRC Researchfish dataset and figure 6 shows the percentage of papers with at least one charity sector author and at least one private sector author by year from 2006-2011. Figure 7 shows the distribution of co-authors by location (excluding the UK).

Figure 5: Distribution of co-authors by sector

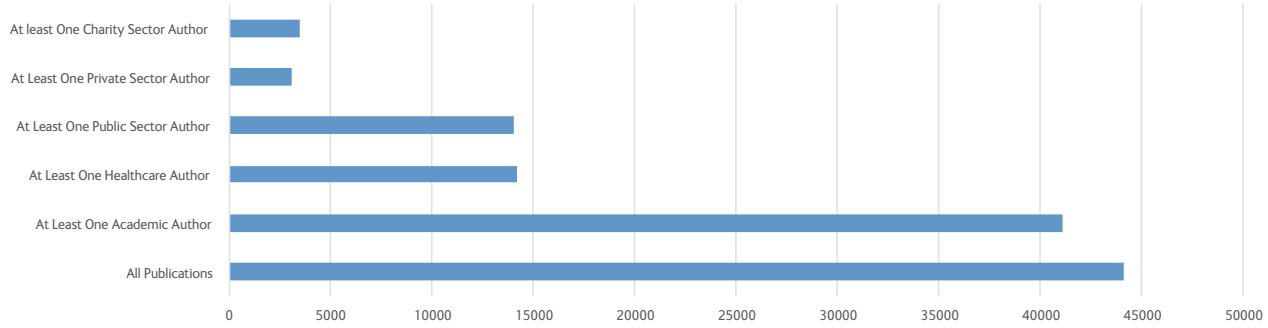
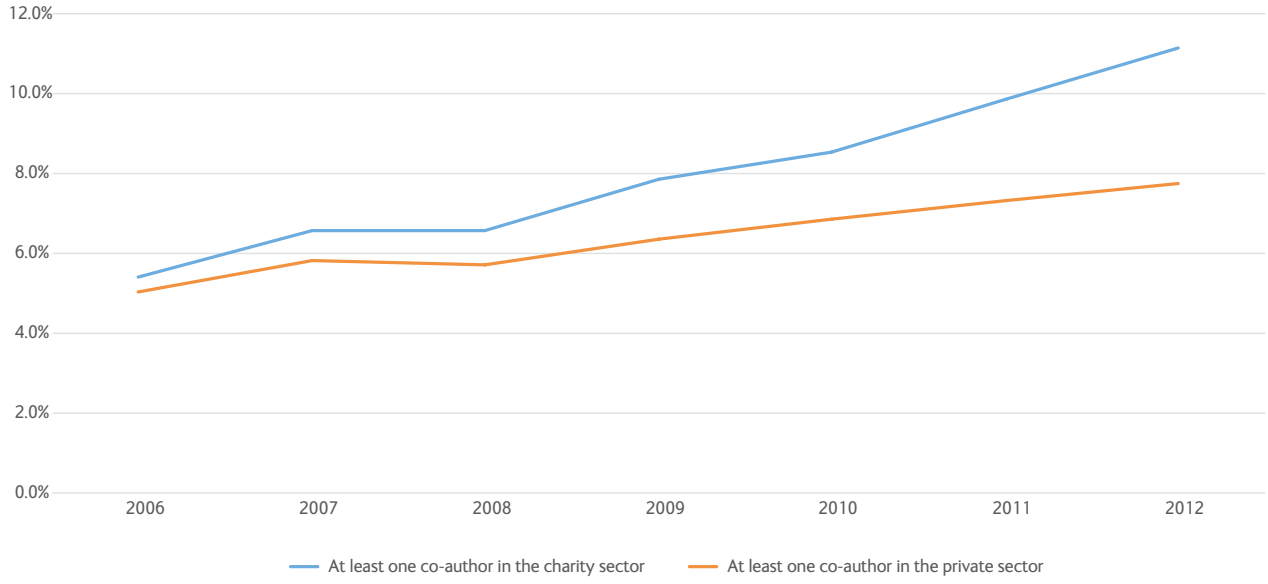
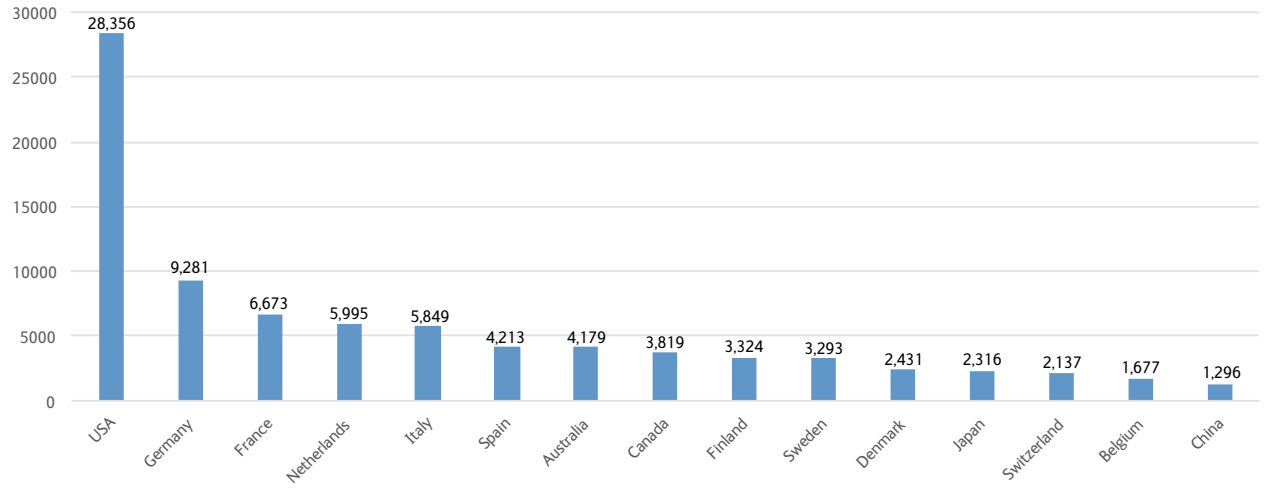


Figure 6: Percentage of papers with at least one charity sector author and at least one private sector author 2006-2011



We see quite a significant rise in the proportion of authors identified as 'from' the private and charitable sectors from 2006 to 2012. This has increased from five per cent from the private sector and 5.4 per cent from the charity sector in 2006 to 7.7 per cent from the private sector and 11.2 per cent from the charity sector in 2012. This is based on the addresses of these authors and as researchers may hold dual appointments and use a university address, the figures may be an underestimate of those employed by either charity or private sector. The MRC has made significant efforts to increase partnership working across these sectors, so these data are an encouraging indication that there is greater collaboration.

Figure 7: Distribution of co-authors by location (excluding the UK)



The distribution of co-authors by location, as expected, is similar to the distribution of collaborations reported by MRC researchers by location.

Open Access

Free and open access to publicly-funded research offers significant social, academic and economic benefits. The Government, in line with its overarching transparency pledge, is committed to ensuring that open access is customary.

In July 2012, the Government announced that it had accepted the recommendations of the report from the National Working Group on Expanding Access to Published Research Findings (the 'Finch Group') – "Accessibility, sustainability, excellence: how to expand access to research publications"[28]. Research Councils UK (RCUK) has used the findings of this report to strengthen its open access policy[29]. The MRC has produced a position statement[30] based on this policy and requires all papers generated as a result of MRC funding to be made publicly available by one of two routes. The preferred route, Gold open access, requires the journal to provide immediate and unrestricted online access to the published paper. Through this route, the researcher may be required to make payment to the publisher of an Article Processing Charge (APC). Where a researcher publishes in a journal not offering Gold open access, they must ensure that their manuscript is deposited into PubMed Central (PMC) or Europe PMC, and made freely available as soon as possible, and in any event within six months of the journal publisher's official date of final publication, in a process known as Green open access.

The MRC aims for 45 per cent compliance with the Gold open access process by the end of year one (2013/14), reaching 74 per cent Gold open access compliance by the end of year five (2017/18).

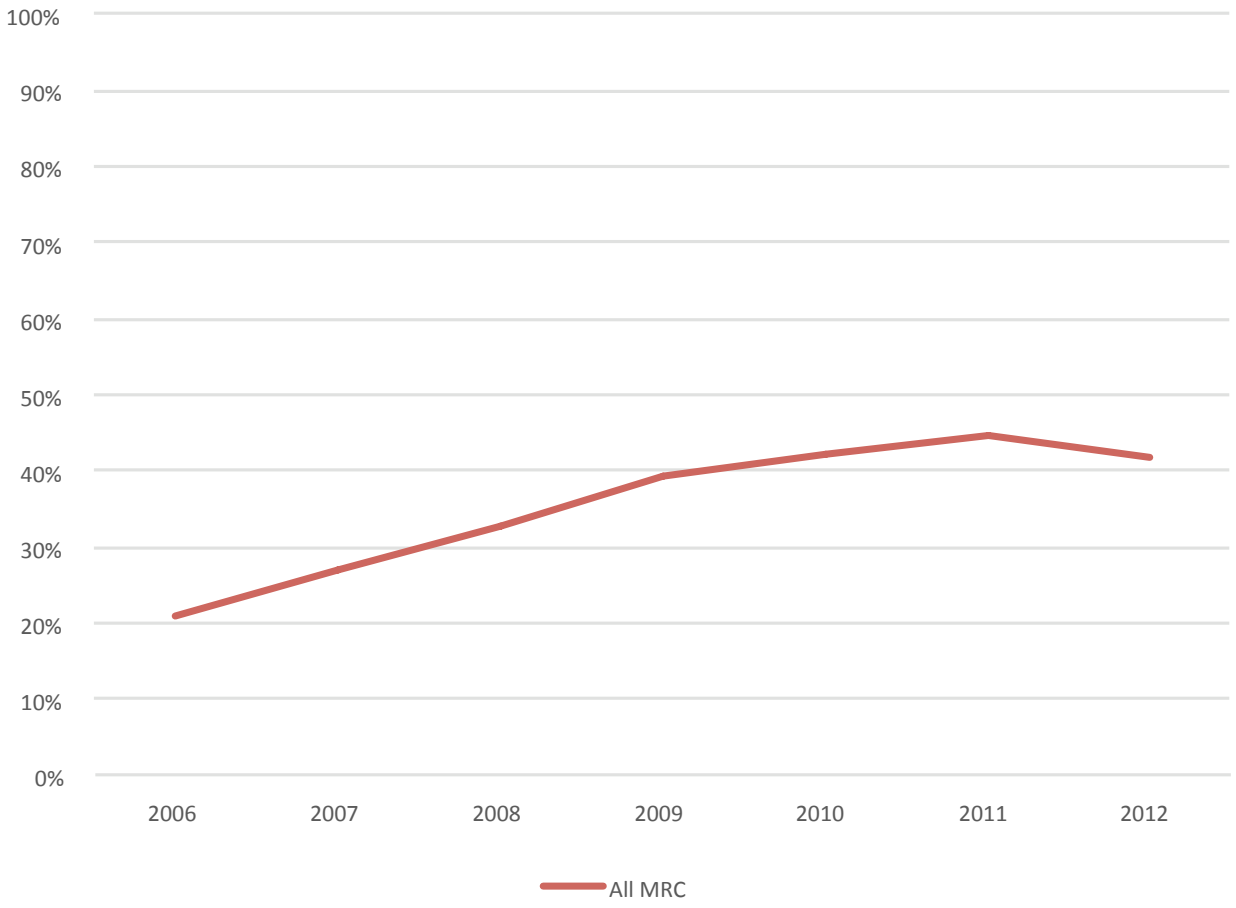
The data we collect through Researchfish will assist in the monitoring of the MRC's compliance rates.

Figure 8 shows the proportion of unique MRC publications produced each year that are currently available in Europe PMC (as of 1 June 2013). The proportion of papers reported via Researchfish, published in 2011, that are openly accessible in Europe PMC is 45 per cent. It should be noted that this will include publications that are not subject to the Open Access policy (for example, books).

Due to time lags in publishing, ID assignment and Europe PMC processing, one would expect lower absolute numbers of publications and proportional compliance in the most recent year, and that these would increase with the next data gathering period.

We will work with Europe PMC to obtain further information about whether these papers were openly accessible within six months of publication, and to filter our results with respect to publication types that have to comply with the open access policy.

Figure 8: Europe PMC availability by publication year



Endnotes

1. Schaffner, Ann C. The future of scientific journals: Lessons from the past. Information Technology and Libraries, v13 n4 p239-47 Dec 1994
2. At the end of this chapter, it is noted that the MRC will utilise information from its Researchfish dataset to assist it in monitoring compliance with the RCUK policy on widening open access to scientific literature http://www.rcuk.ac.uk/documents/documents/RCUKOpenAccessPolicy.pdf.
3. http://thomsonreuters.com/web-of-science/
4. http://www.ncbi.nlm.nih.gov/pubmed
5. "Public to see impact of medical research funding" http://www.scientistlive.com/content/public-see-impact-medical-research-funding
6. http://europepmc.or/Funders/
7. Funding sources should be acknowledged in journal articles as per the 2008 statement from the Research Information Network http://www.rin.ac.uk/our-work/research-funding-policy-and-guidance/acknowledgement-funders-journal-articles. This allows PubMed and Europe PMC to extract award and funder details from acknowledgements.
8. http://researchanalytics.thomsonreuters.com/
9. Includes papers submitted via Researchfish for any date, not limited to 2006-2012.
10. See below section on citation impact.
11. Boyack and Jordan "Metrics associated with NIH funding: a high level view" (2011) *J Am Med Inform Assoc* 2011;18:423-431 http://jamia.bmj.com/content/18/4/423.abstract
12. Based on unique publications reported.
13. Normalised citation impact data and analysis: Evidence, Thomson Reuters UK
14. http://altmetrics.org/manifesto/
15. http://www.zotero.org/blog/zoteros-next-big-step/
16. http://www.mendeley.com/
17. Initiatives such as Altmetrics (http://www.altmetric.com/) are working with publishers and social media (twitter, blogs etc.) to introduce ways to capture and analyse "article-level metrics".
18. Citations were taken at the end of 2012 for all papers published up to the end of 2011.
19. Publications were indexed as per the subjects in the Thomson ISI Web of Science database. Each publication could be indexed under more than one subject.
20. Excluding methodology, review and committee papers.
21. See chapter 8 "Intellectual property" for a long-term case study on therapeutics for haemophilia B.
22. http://www.controlled-trials.com/ISRCTN91273375
23. 'Immediacy' may be measured by how quickly an article results in citations after it is published.
24. Citation 'half life' may be calculated from the length of time that an article continues to accumulate citations after it is published.
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27. Newman, MEJ, Coauthorship networks and patterns of scientific collaboration, *Proceedings of the National Academy of Sciences of the United States of America* April 6, 2004 vol. 101 no. Suppl 1
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29. http://www.rcuk.ac.uk/documents/documents/RCUKOpenAccessPolicy.pdf
30. http://www.mrc.ac.uk/Ourresearch/Ethicsresearchguidance/Openaccesspublishing/Positionstatement/index.htm

researchfish

MRC Medical Research Council

Outputs, outcomes and impact of MRC research: 2012 report

02: Collaborations

Collaborations

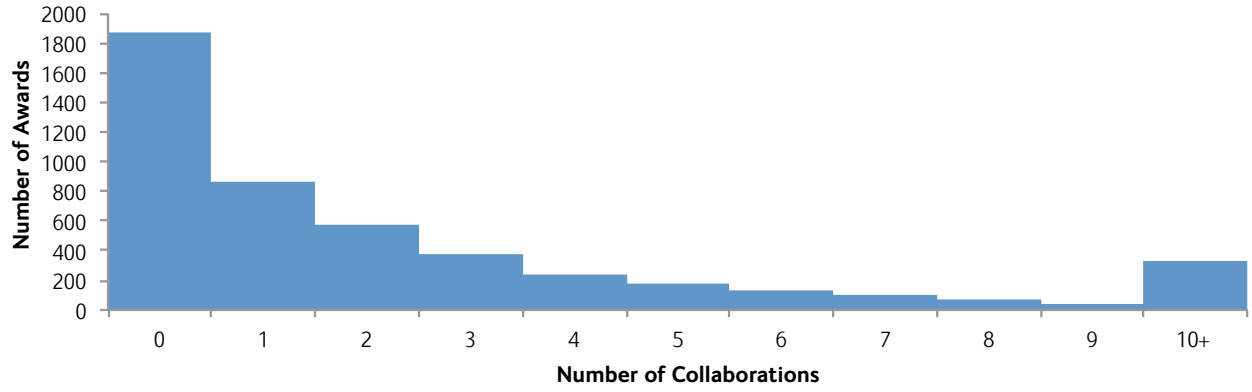
Summary

Collaborative work is of increasing importance in facilitating the delivery of all strands of the MRC's mission to improve the health of the nation through world-class medical research.

Recipients of 61 per cent of MRC awards reported that they had embarked on new collaborations as a result of their MRC-funded work. Each collaboration can include a number of partners across different sectors. These partners may be funded from multiple sectors (for example, charitable, public, and private sources) and are not confined to just the UK. Researchers reported a variety of purposes for engaging in a collaboration, including funding, access to equipment, and provision of analytical techniques and expertise.

- Recipients of 61 per cent of awards (2,900) reported that they had been part of a collaboration between 2006 and 2012.
- These collaborations involved a total of 15,313 partner organisations.
- The average number of partner organisations linked via collaborations to each award was 5.28, an increase on last year's average of 4.57.
- Seven per cent (327) of awards were highly collaborative, reporting links to more than ten partner organisations. Figure 1 shows the distribution of numbers of partners per award.

Figure 1: Number of collaborative partners per award



Locations of collaborations

The majority of collaborations involved partners in the United Kingdom (54 per cent), followed by the rest of Europe (19 per cent) and North America (13 per cent). Table 1 shows the numbers of partner organisations by location and figures 2 and 3 illustrate the distribution of international (excluding Europe) and European (excluding UK) partners respectively. Figure 4 shows the top 25 location countries (excluding the UK) for partner organisations.

Table 1: Number of collaborations per award

Location of collaborating partner organisations	Number of collaborating partners	Percentage of total
United Kingdom	7,389	54%
Europe	2,511	19%
North America	1,704	13%
South America	72	1%
Asia	437	3%
Africa	231	2%
Oceania	268	2%
Global	605	4%
Unknown	346	3%
Total	**13563**	**100%**

Figure 2: Distribution of international (excluding Europe) collaborations

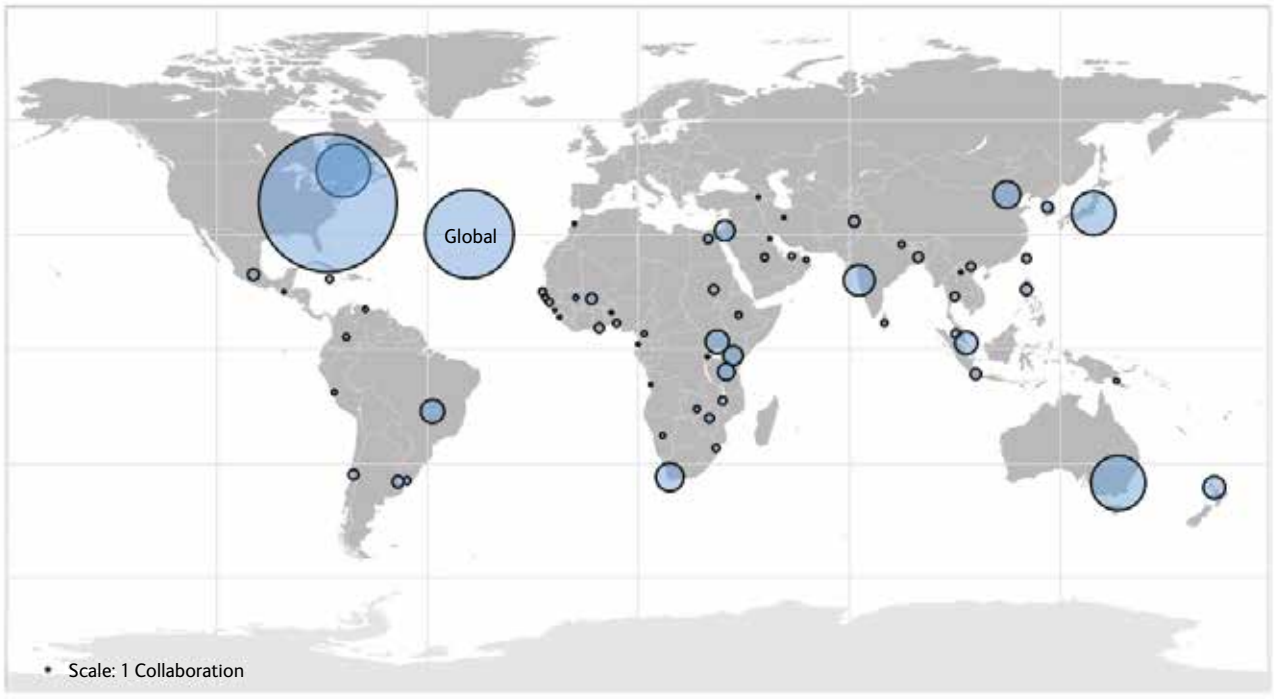


Figure 3: Distribution of European (excluding UK) collaborations

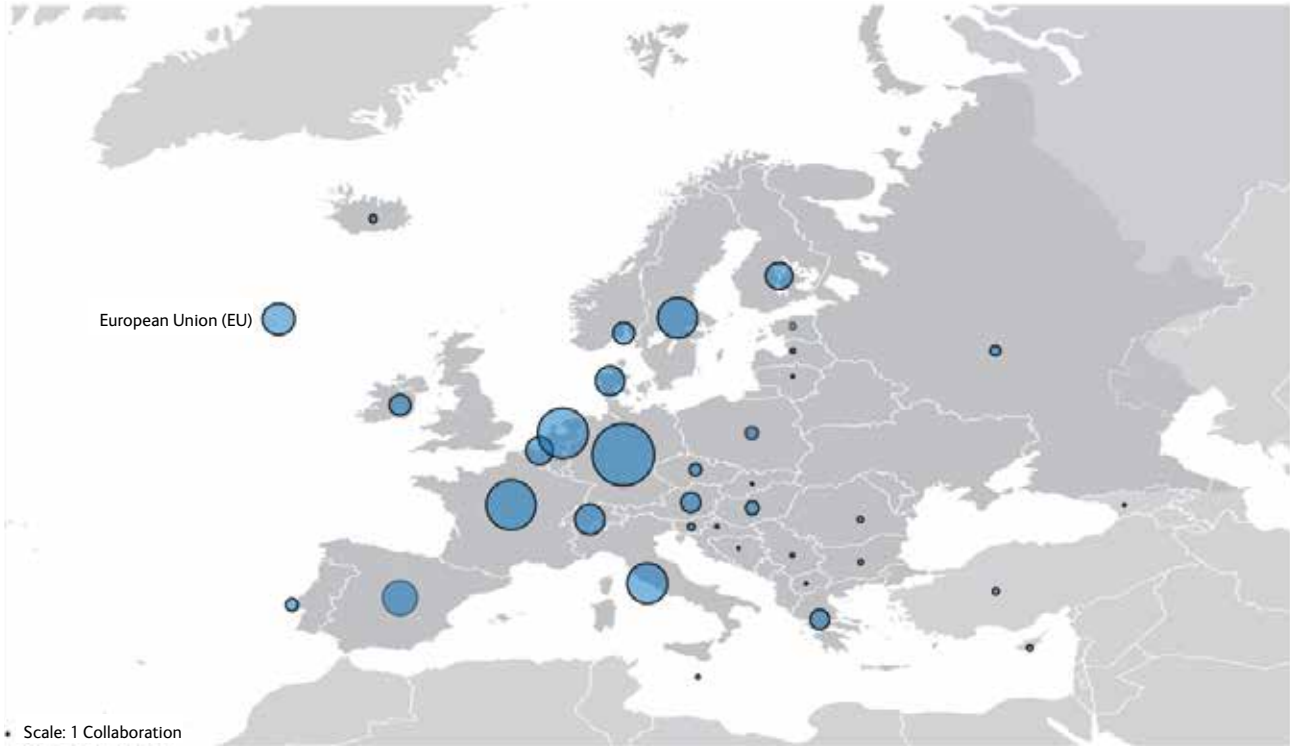
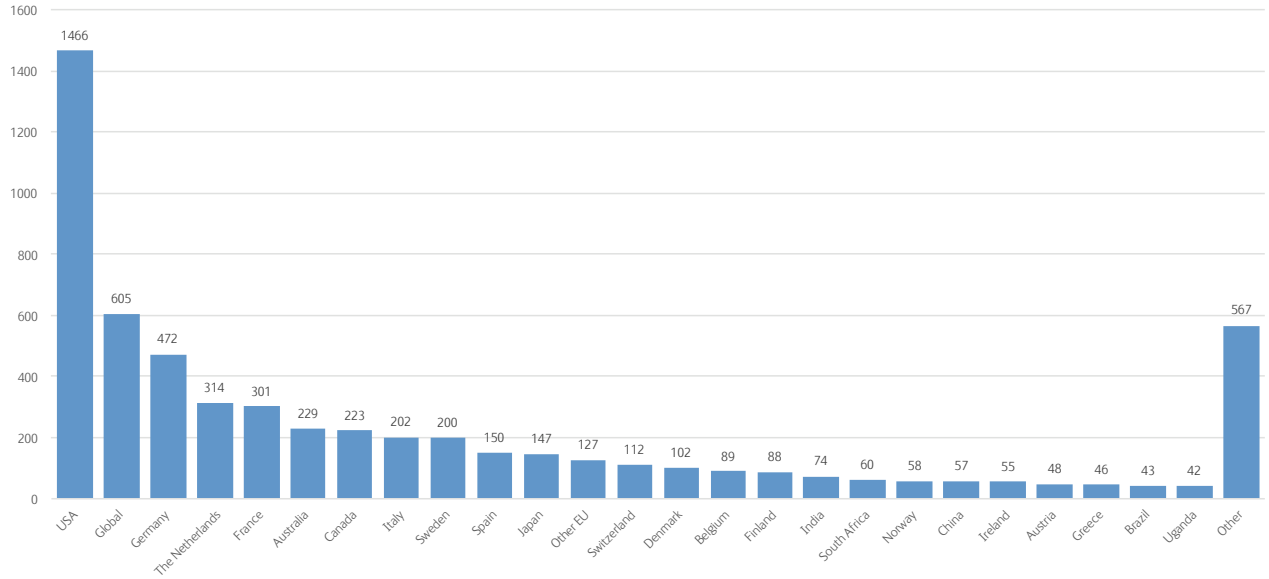


Figure 4: Top 25 locations (excluding the UK) for partner organisations



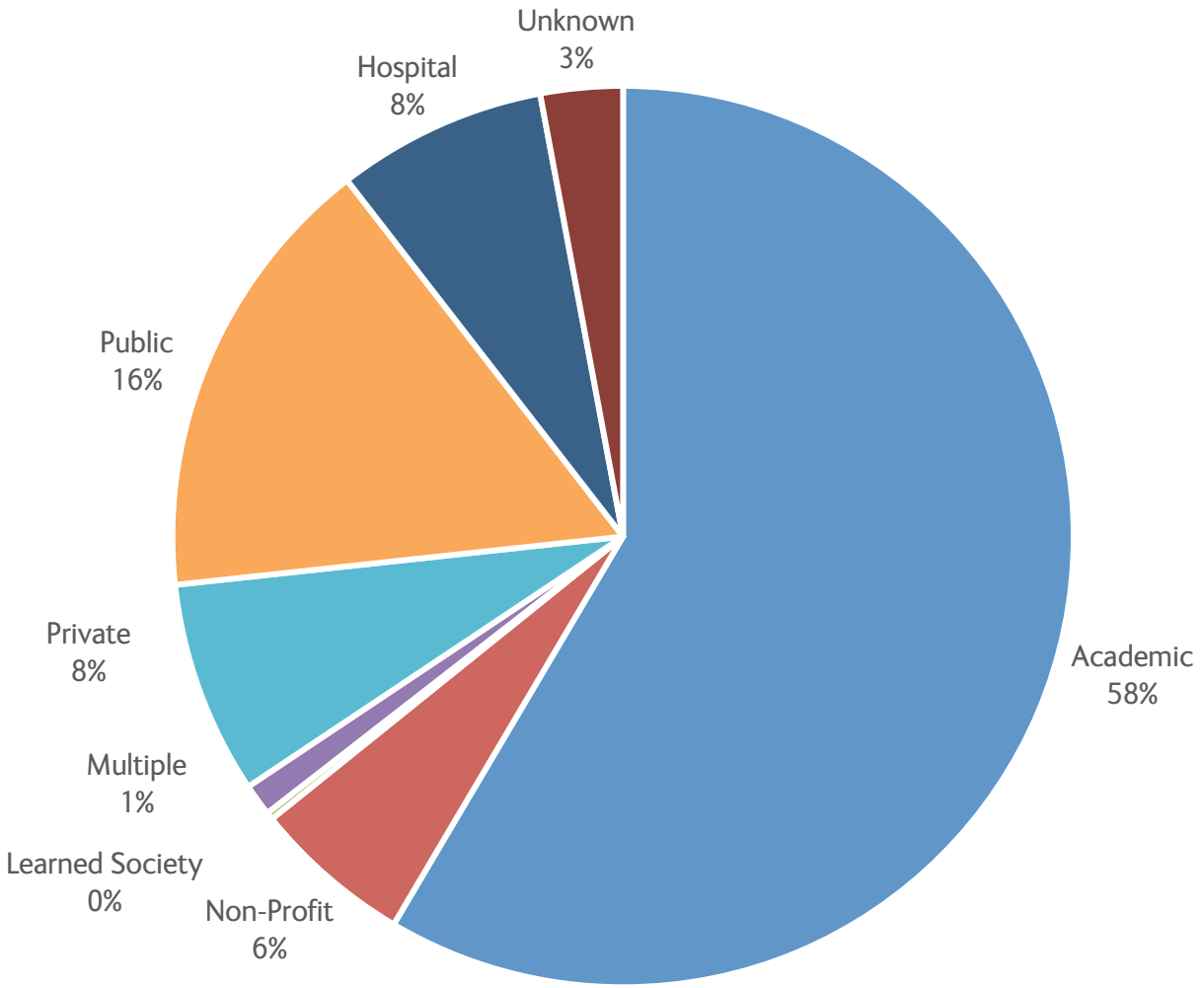
13,225 partner organisations were categorised according to their location (339 were not categorised, either due to insufficient information being available to identify the partner, or because these data had not been checked fully by the

time of analysis[1]). Results are similar to the 2010 analysis, although partners in Australia and Canada have increased their prominence in this ranking.

Collaborations by sector

Researchfish data allow us to examine how researchers are engaging with partners from different sectors. Of particular interest is the extent to which researchers are actively collaborating with the private sector. The majority of collaborations reported were with academia (59 per cent), followed by the public sector (16 per cent), and then the private sector (eight per cent) and hospitals[2] (eight per cent). This is similar to the results in the 2010 analysis, although the categories have been revised with the introduction of the hospital/healthcare organisation category. It is noteworthy that there has been a small increase in the proportion of private sector interactions, consistent with the results from publication data. Figure 5 shows the proportion of MRC collaborations by sector.

Figure 5: Proportion of MRC collaborations by sector



Selected examples of collaborations

Professor Chris Ponting (MRC Functional Genetics Unit)
The Broad Institute, Massachusetts

Professor Ponting has contributed to many landmark genome sequencing projects, including the human, mouse, rat and chicken genomes. His work predominantly now focuses on disease genomics, non-coding RNA, and next-generation sequencing functional analyses. He was part of the team of scientists who sequenced the genome of the green anole lizard in 2011, the first non-bird species of reptile to have its genome sequenced and assembled. The team included researchers at the Broad Institute, who provided expertise in genome sequencing and assembly. This research may offer insights into how the genomes of humans, mammals, and their reptilian counterparts have evolved; one of the questions this genome may help resolve relates to the origin of conserved, non-coding elements in the human genome. These regions do not contain protein-coding genes but are thought to have critical roles since they have remained unchanged for millennia.

Professor Petra Meier (University of Sheffield)
NIHR School for Public Health Research

Professor Petra Meier's research team at the University of Sheffield leads the NIHR School for Public Health Research (SPHR)'s programme on alcohol strategy, developed in 2012 and providing skills in alcohol policy modelling and analysis. The collaboration of eight academic institutions benefits from its multi-disciplinarity approach, with expertise drawn from a variety of fields, including nutrition, behavioural science, health services research and health economics. An outline bid for a school-wide programme of alcohol policy has been approved for further development by the SPHR executive group.

Professor Simon Gayther (University College London)
Collaborative Oncological Gene-environment Study

The Collaborative Oncological Gene-environment Study (COGS) is a pan-European consortium of investigators performing genetic and environmental risk factor studies of breast, prostate and ovarian cancers, funded by the European Commission and 7th Framework Programme. **Professor Gayther's** research has focused on a genome-wide association study (GWAS) to identify moderate/low penetrance ovarian cancer susceptibility allele and have found strong evidence that multiple genetic susceptibility loci exist. In 2013, the study revealed that it had discovered more than 80 genetic 'spelling mistakes' increasing the risk of breast, prostate and ovarian cancer. For the first time, researchers also have a relatively clear picture of the total number of genetic alterations that can be linked to these cancers and ultimately hope to be able to calculate the individual risk of cancer, to better understand how these cancers develop and to be able to generate new treatments.

Dr Artemis Koukounari (Imperial College London)
Kenyan Institute for Medical Research, Wellcome Trust and London School of Hygiene & Tropical Medicine

The main focus of **Dr Koukounari's** current research is to develop and apply biostatistical methods to further understanding of the prevalence and intensity of schistosomiasis and of the ocular bacteria causing trachoma, a bacterial eye infection that is the leading cause preventable blindness worldwide. Dr Koukounari's research also looks at analysing the likelihood of their elimination and interventions based on Mass Drug Administration, as well as evaluating the performance of the diagnostic tools currently used for the monitoring of these two infections. This is the subject of the collaboration where all collaborators are experts in the field of neglected tropical diseases, epidemiology and mathematical modelling. Dr Koukounari is the lead statistical collaborator on reinfection studies. In 2011, this work attracted a $3.4 million grant from the Bill & Melinda Gates Foundation.

Dr Stephanie Cragg (University of Oxford)
Pasteur Institute, Paris

Dr Cragg's research focuses on understanding dopamine neurotransmission, particularly within the basal ganglia and reward-related processing centres. She uses electrochemical and theoretical approaches to explore how dopamine signals are pre-synaptically controlled, to understand how dopamine encodes motor and reward-related functions and ultimately, to gain insight into therapeutic strategies for Parkinson's disease and drug addiction. The Pasteur Institute has provided Dr Cragg with access to novel transgenic animals and vectors to aid her research into the function of alpha5 subunits in nicotinic receptor control of dopamine transmission. As a result of this work, Dr Cragg was awarded a grant funded by Parkinson's UK, which in 2012, yielded research that uncovered a new way to trigger nerve cells to release dopamine – by activating a small group of neighbouring cells called 'cholinergic interneurons'.

Private sector collaborations

In December 2011, the UK government launched its Life Sciences Strategy[3] to bolster UK life sciences and to ensure there is a continuous pathway between developing an idea and commercialising it. In this respect, collaboration between the MRC and the private sector has never been more important.

In the first year of the strategy, the MRC and AstraZeneca awarded funding to 15 research projects in a ground breaking collaboration that gave academic researchers unprecedented access to 22 chemical compounds. Scientists will use the compounds to study a broad range of conditions from common diseases like Alzheimer's, cancer and lung disease through to rarer conditions such as motor neurone disease and muscular dystrophies.

Also established under the Life Sciences Strategy was the £180m Biomedical Catalyst, an integrated translational research programme allowing the MRC, in conjunction with the Technology Strategy Board (TSB), to provide support for projects ranging from "confidence in concept" studies through to late stage R&D up to, and including, phase 2 clinical studies. The progamme provides seamless support for both academic- and business-led research and development projects, with the aim of developing innovative solutions to healthcare challenges and supporting the maturation of ideas from concept to commercialisation. In June 2013, it was announced that the TSB would receive £185 million additional funding, part of which will be allocated through the Biomedical Catalyst.

In stratified medicine the MRC is working with ABPI to develop a consortia of experts to address disease stratification using a disease-focused approach. Funding for the first three collaborations, in rheumatoid arthritis, hepatitis C and a rare genetic condition called Gaucher disease, was announced in December 2012. The three consortia will combine 34 academic groups and 20 industry partners with charities and patients across the UK.

The MRC has established the MRC Industry Collaboration Agreement (MICA), a mechanism to support the establishment of an agreement between academic and industry research partners. This can be applied to the majority of the MRC's funding schemes and calls. It facilitates collaboration as it allows partners to clearly specify arrangements for relative responsibilities, governance, regulatory approvals, indemnity, intellectual property rights, reporting and access to data and samples before a project starts.

A detailed list of the top 18 companies involved in collaborations with the MRC, based on number of collaborations[4], can be found at the **Annex**.

Selected examples of collaborations with the private sector

Professor Roger Cox (MRC Mammalian Genetics Unit)
Partnered with Amgen Inc

Amgen Inc. is a UK developer and manufacturer of innovative human therapeutics. The company pioneered the development of novel products based on advances in recombinant DNA and molecular biology. Professor Cox's research is focused on the development of new mouse models for type 2 diabetes that will allow the identification of key genes and/or pathways for a systematic analysis of the process of disease development and the effect of environmental factors. Since the collaboration began in 2010, Amgen Inc. has provided sequencing and genotyping, research support and metabolic disease expertise. Professor Cox's research has already identified many genetic factors involved in the development of type 2 diabetes and further studies are on-going.

Professor Adrian Hill (University of Oxford)
Partnered with Okairos

Okairos is a clinical-stage biopharmaceutical company based in Switzerland. Professor Hill's research focuses on vaccine development, particularly assessing T cell-inducing vaccines against diseases such as tuberculosis and malaria. To achieve greater levels of protective efficacy, his group is currently developing more immunogenic prime-boost regimes involving recombinant adenoviruses as priming agents and MVA as a boosting agent. Okairos supplied an adenoviral vaccine vector for the use in phase I and phase IIa clinical trials, adding to the evidence that a CD8-T cell-mediated vaccine can provide vaccination against disease. In 2013 the Bill & Melinda Gates Foundation awarded a $2.9 million grant in support of a collaboration between the University of Oxford, Okairos and Aeras, a non-profit biotech advancing TB vaccines for the world, to develop scalable methods to enable large-scale production of multiple novel simian adenovirus vector constructs.

Professor Derek Mann (University of Newcastle)
Partnered with GlaxoSmithKline (GSK)

In 2011 GSK struck a broad agreement with Professor Mann's MRC-funded group to carry out collaborative studies aimed at discovery of therapeutics for fibrosis in the liver, lung and kidney. Three full-time technicians and 1 full time administrator are dedicated to this work and are embedded within the academic group at Newcastle. Several GSK lead compounds are now in pre-clinical studies at Newcastle, and a programme of drug discovery has been initiated at GSK in Stevenage to generate novel and highly potent 5-HT2B receptor antagonists.

Professor Sir Mark Pepys (University College London)
Partnered with GlaxoSmithKline (GSK)

Professor Mark Pepys has a long established collaboration with GSK and in 2011, was selected by the company as its first academic 'superstar' for long term partnership to develop medicines more cost effectively. His research on amyloidosis has led to the development of a new dual drug-antibody treatment for systemic amyloidosis. Amyloidosis is caused by a build-up of abnormal proteins (amyloid) in body tissues, which leads to organ failure and is the cause of death in one per thousand of the population in developed countries. In conjunction with GSK, Professor Pepys developed a small molecule drug, CPHPC, and combined CPHPC treatment with monoclonal antibodies that sought out amyloid deposits in the organs of mice. GSK has since humanised the mouse monoclonal antibodies, and in 2012 conducted a phase 1 trial, enabling progression to a single dose first in human study of antibodies co-administered with CPHPC. A second project, developing potential drugs to target transthyretin amyloidosis is in progress. Novel transthyretin stabilising compounds have been identified and are being evaluated and refined for eventual clinical testing.

Dr Catherine Merry (University of Manchester)
Partnered with Orla Protein Technologies Ltd

Orla Protein Technologies Ltd's key assets are its protein and biosurface expertise, including protein design and manufacture, for biosurface applications. Dr Catherine Merry worked with Orla since 2009 on a knowledge transfer project to develop novel protein-based detection devices for heparan sulphate. Heparan sulphate binds to a variety of protein ligands and regulates a wide variety of biological activities, including developmental processes, angiogenesis, blood coagulation and tumour metastasis. Work has been undertaken to develop a system for the recognition of heparan sulphate and to display heparan sulphate-binding peptides. In 2011, this collaboration attracted a £75k grant from the Engineering and Physical Sciences Research Council (EPSRC).

Dr Wendy Bickmore (MRC Human Genetics Unit)
Partnered with NEC Corporation

The NEC Corporation, a global company with a division interested in biomedical imaging based in Japan, funded a technician in Dr Wendy Bickmore's group at the MRC Human Genetics Unit for two years to study how nuclear organisation is perturbed in clinical biopsies from breast cancer. Although the funding for this collaboration has now finished, MRC HGU and NEC are still actively collaborating. As a result of the work initiated on this collaboration, Dr Bickmore was awarded a five-year grant from the charity Breakthrough Breast Cancer and initiated close contacts with the local consultant pathologist and breast cancer surgeon at NHS Lothian.

Professor I Mhairi Macrae (University of Glasgow)
Partnered with Oxygen Biotherapeutics, Inc. (North Carolina)

Professor Macrae approached Oxygen Biotherapeutics to access the perfluorocarbon "Oxycyte" to use for further development of an MRI acute stroke diagnostic technique (previously funded by an MRC project grant). This has opened up the possibility of investigating the therapeutic potential of Oxycyte combined with hyperoxia in the treatment of stroke. The Chief Scientist Office (CSO) for Scotland awarded £225k of further funding in 2011 to take these ideas forward.

Professor Tracy Hussell (Imperial College)
Partnered with GlaxoSmithKline (GSK) and AstraZeneca (AZ)

Professor Tracy Hussell's research focus is in the field of mucosal immunology and infectious disease. She has developed a research group studying immunity, pathology and vaccination to influenza virus infection with a special interest in the secondary bacterial complications that ensue. In 2012, she was appointed director of the Manchester Collaborative Centre for Inflammation Research (MCCIR), a world-leading centre for basic and translational research in inflammation and inflammatory disease, funded through a unique partnership between academia and industry – the University of Manchester, GSK and AZ. The research generated through MRC funding forms the basis of this new centre.

Dr John Marshall (Queen Mary, University of London)
Partnered with MedImmune

MedImmune is the global biologics research and development arm of AstraZeneca. MedImmune provided access to antibody 264RAD, which Dr Marshall has demonstrated inhibits the activity of integrin alphav beta6, subsequently reducing tumour growth. As a result of the work initiated on this collaboration, in 2012, Dr John Marshall was awarded a three-year grant from the charity Breast Cancer Campaign (BCC).

Endnotes

1. The Researchfish system includes an extensive database of research organisations, funding organisations, companies etc. In the majority of cases, researchers are able to select a location from this database. All locations in the database are already categorised according to location and sector. If a partner organisation is not present in the database, then the researcher can enter details which enter a workflow for validation, categorisation and addition to the database for future reference.
2. This category includes NHS trusts, university hospitals and primary care practices.
3. https://www.gov.uk/government/publications/uk-life-sciences-strategy
4. The reported data have been cleaned to best reflect genuine partnerships between academics and industry. Therefore, duplications (for example, in submission, in reporting funding and collaboration from the same partnership, in reporting of the same partnership in multiple years),travel grants, and PhD scholarships have been removed. The collaboration years refer to the year the collaborations began.

Annex: Top 18 company list based on number of collaborations

Company name	Number of unique collaborations	Total financial contribution (£)	Repeat partnerships	Number of collaborations reported as on-going
GSK	97	26,849,064	5	64
Pfizer	49	9,348,450	2	49
AZ	43	7,573,559	4	28
Novartis	31	1,401,743	0	23
Merck	24	26,838,188	2	13
Roche	20	10,772,601	4	12
BUPA	18	2,902,340	0	5
Eli Lilly	15	1,852,315	0	12
Wyeth	14	5,015,325	0	2
Sanofi	13	1,807,009	2	8
Unilever	12	1,819,000	2	6
Amgen Inc	11	1,665,900	0	4
Abbott	10	1,057,578	1	5
Bayer	10	6,476,813	1	7
UCB	9	2,311,963	1	8
Boehringer	8	1,016,780	0	4
JnJ	8	471,800	0	6
Other	643	75,263,424	6	427
Total as at end of 2012	**1035**	**184,443,852**	**30**	**653**

	Percentage reported as on-going	Number of collaborations before 2009	Number of 2009 collaborations	Number of 2010 collaborations	Number of 2011 collaborations	Number of 2012 collaborations
	66%	48	20	5	12	12
	39%	23	9	8	2	6
	65%	21	7	3	5	7
	74%	16	4	3	6	2
	54%	14	1	2	4	3
	60%	12	1	3	3	1
	28%	7	4	3	1	2
	80%	7	2	2	0	3
	14%	10	2	1	1	0
	62%	7	1	2	2	0
	50%	9	0	0	1	1
	36%	6	2	1	1	1
	50%	7	1	0	1	1
	70%	5	2	1	1	1
	89%	2	3	1	1	2
	50%	2	0	1	2	3
	75%	2	0	4	2	0
	66%	326	82	93	80	59
		524	**141**	**133**	**125**	**104**

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MRC Medical Research Council

Outputs, outcomes and impact of MRC research: 2012 report

03: Further funding

Further funding

Summary

There are many potential sources of funding for medical researchers. It is therefore important in any analysis of research output that information is gathered about other funding held by MRC-supported research groups. Information was sought on funding which was gained (at least in part) as a result of obtaining MRC support. Success in obtaining further funding should indicate that the research group has established a high quality track record and is presenting attractive proposals for future research. With respect to this aspect, further funding can be viewed as an outcome.

Another reason to collect information on other sources of funding available to the research group is that the data will, in time, contribute to realising future output; further funding can be viewed as a leading indicator.

The Higher Education Statistics Agency (HESA)[1] publishes data on the research income of UK universities. This information is helpful to contextualise the results from MRC Researchfish. HESA estimate that in 2011/12, UK universities received £1.5billion from the research councils, BIS and the learned societies, £900million from UK-based charities, £800m from central government bodies/local authorities, health and hospital authorities, £280m from industry, £600m from EU sources, and £320m from non-EU sources for research; a total income to UK universities of approximately £4.5bn in grants and contracts for research across all disciplines (16 per cent of total university income). The reports gathered by MRC Researchfish focus only on researchers who have received MRC support, and emphasise only new research contracts obtained.

We have identified issues with over-reporting (for example of European Commission and MRC funding), and duplicate reporting of grants. Furthermore it should be noted that the income from MRC units and institutes reported via MRC Researchfish, would not be included in the HESA statistics. However according to MRC Researchfish, out of the £562m of further funding that was estimated to have been spent in 2011/12, £14.1m (three per cent) was found to be from the private sector, and £124m (22 per cent) from non-private sector sources outside the UK overall. These figures are of similar proportions to the HESA information.

- Researchers reported receiving further funding in 48 per cent of awards. 7919 instances of further funding were reported.
- Of those who had received further funding, the average number of instances was between three and four.
- Recipients of 128 awards reported more than ten instances of further funding. Figure 1 shows the number of instances per award.

Figure 1: Number of instances of further funding per award

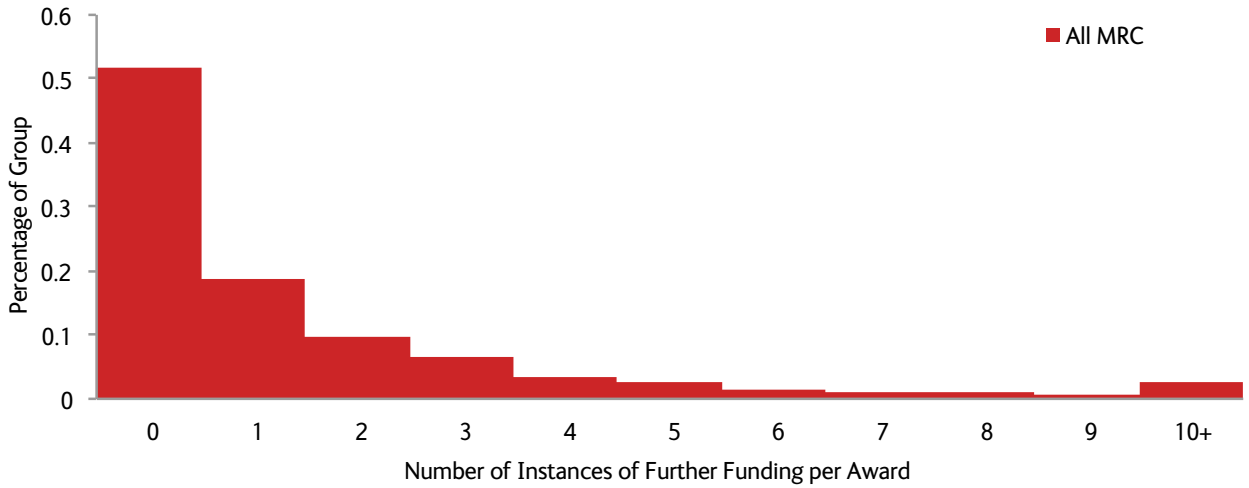


Figure 1 shows that the distribution of further funding is skewed, with just over 50 per cent of MRC awards not linked to an instance of further funding. The reasons for this are being examined and may include under-reporting, and/or new awards (at a stage too early to report further funding).

Value of further funding

Researchers reported a total value of £2.3bn in funding received from 2006 to 2012[2], with the average total value being £992.3k among those reporting further funding. We expect the total amount of further funding captured against each year to steadily increase as current and all previously live awards report new 'follow-on' funding. A total value of £562m was reported to have been received in 2011/2012, which is an increase on last year's total of £473m. Figure 2 shows the value of further funding leveraged per year.

Ten per cent of all awards received more than £1m in further funding. A breakdown of further funding by value is shown in figure 3.

Figure 2: Value of further funding by year

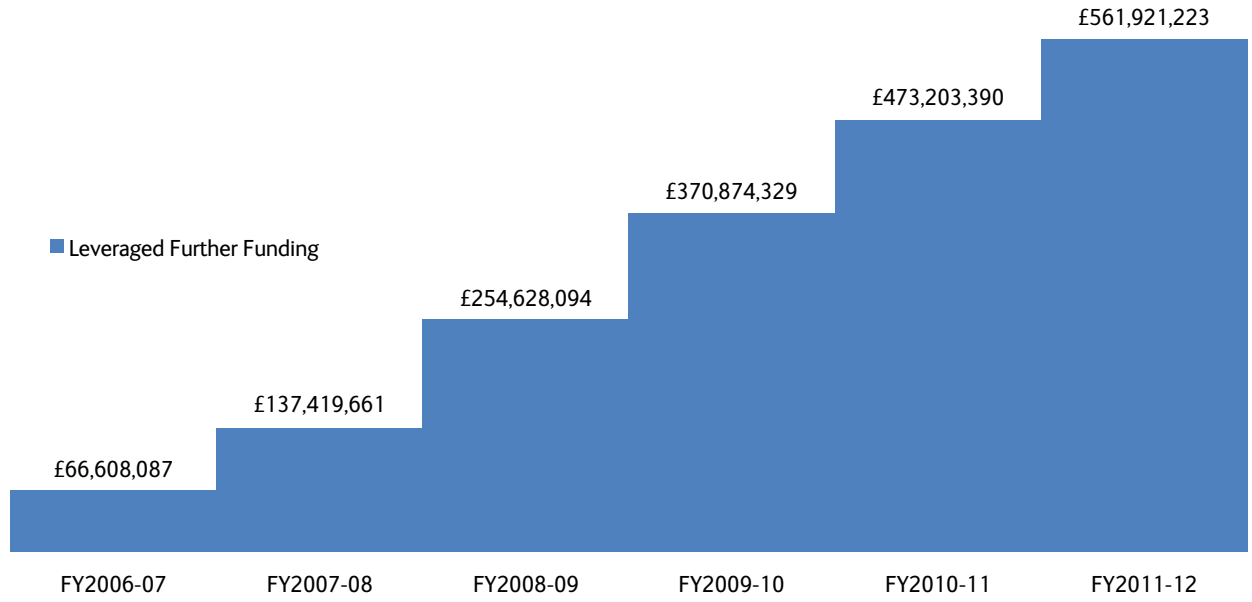
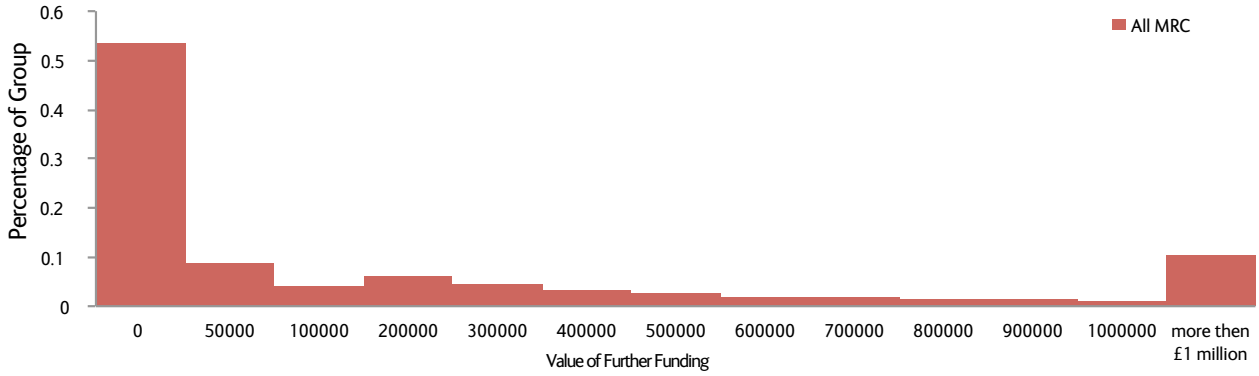


Figure 3: Distribution of further funding by value



Value of further funding by sector and location

The sources of further funding have been coded for country and sector to gain a greater understanding of the importance of other countries, governments, companies and non-profit organisations in funding the same research as the MRC.

» The majority of further funding was leveraged from the United Kingdom between 2006 and 2012 - 71 per cent of further funding (£1.6bn). 14 per cent of further funding (£319m) was obtained from the rest of Europe. Figures 4 (European, excluding UK) and 5 (International, excluding Europe) show the amount of further funding by location.

- The largest value of further funding between 2006 and 2012 came from the public sector (£1.1bn – 47 per cent of the total further funding reported). This was closely followed by non-profit organisations (£916m – 40 per cent of the total further funding reported). Figure 6 shows the value of further funding by sector.
- Three per cent of further funding (£14.1m) was leveraged from the private sector in 2011/12.
- Researchers reported the leveraging of further funding from 957 different funders. 791 have contributed £10k or more in the six financial years between 2006/07 and 2011/12.
- The Wellcome Trust provided the largest value of further funding, contributing £397m between 2006 and 2012. This was followed by the National Institute for Health Research (£301m). A distribution of the top ten funders by value is shown in figure 7.
- The largest overseas funder was the European Commission, contributing £261m between 2006 and 2012, followed by the National Institutes of Health (£81m).
- The largest single private sector funder is Merck, providing around £21.8m in this period. This is followed by Nokia, providing a total of £8.1m and GlaxoSmithKline (GSK), providing £7.0m[3].
- Multiple funders represented £28.5m of funding. This was a category assigned where funding contributions to consortia could not be disaggregated. It is likely that part of this funding is from the private sector or from outside the UK.

Figure 4: Amount of European (excluding UK) further funding by location

Figure 5: Amount of International (excluding Europe) further funding by location

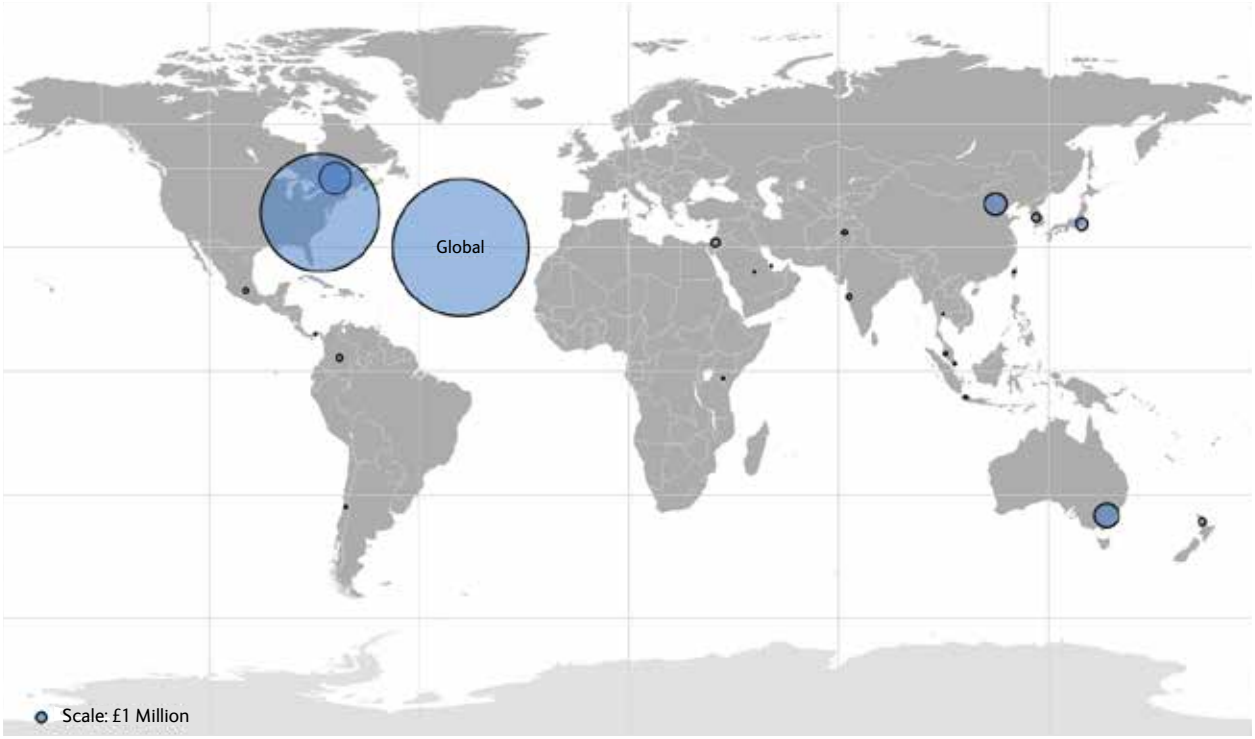


Figure 6: Value of further funding by sector

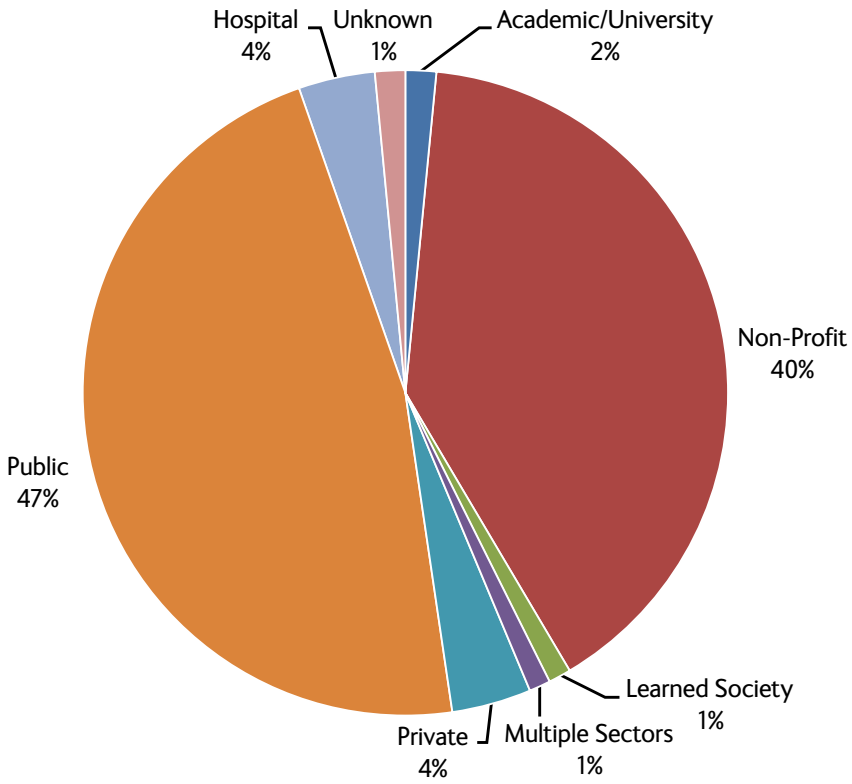
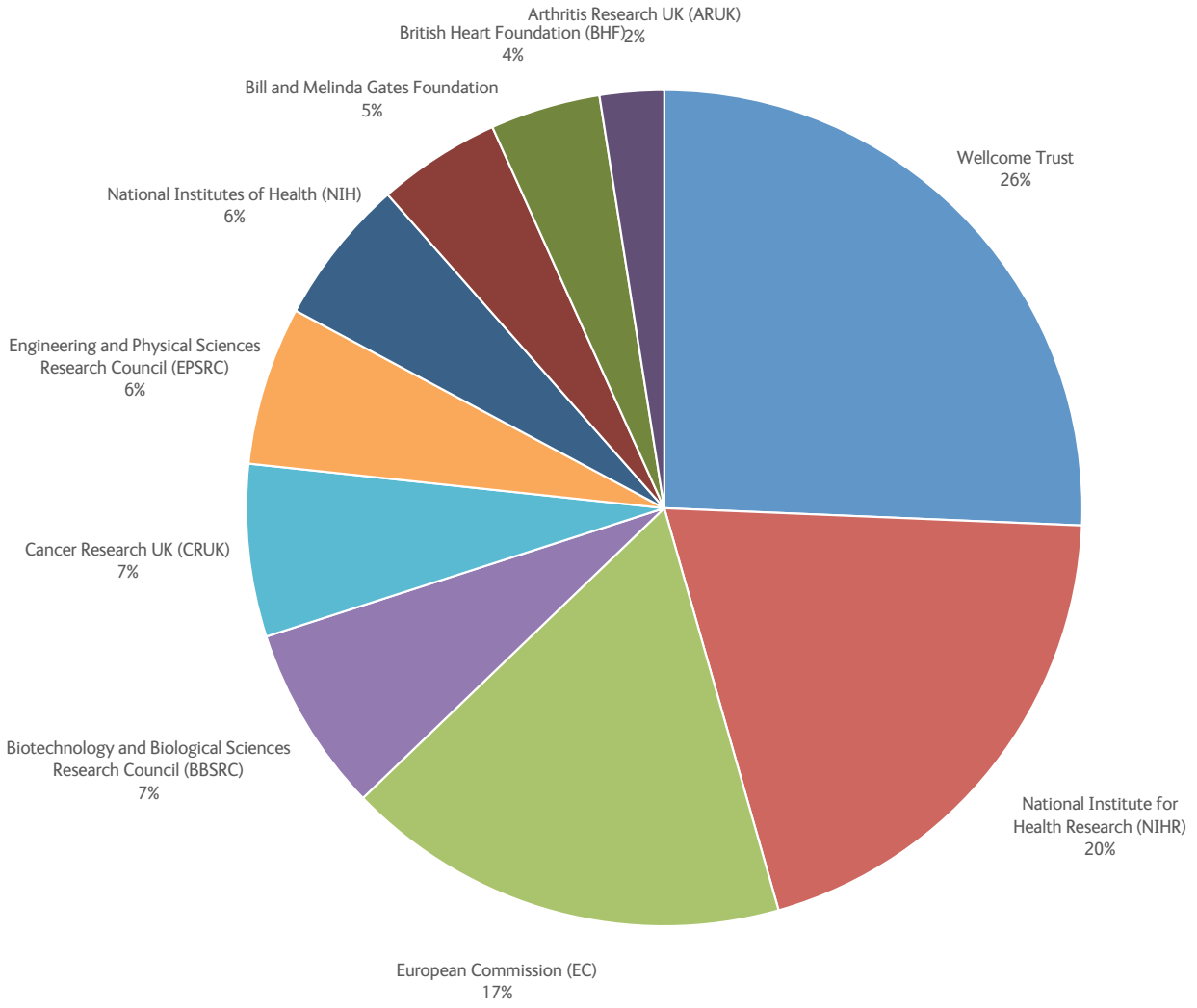


Figure 7: Top ten funders (ranked by value)



Selected examples of further funding

Dr Christina Davies (MRC Clinical Trial Service Unit): £1m from AstraZeneca (2006-2015)

Dr Davies' research focuses on the treatment of early breast cancer. She is responsible for the scientific direction of the continuing international Adjuvant Tamoxifen: Longer Against Shorter (ATLAS) study of tamoxifen in breast cancer, which has shown thattaking the drug tamoxifen for ten years after breast cancer surgery, rather than the usual five, further reduces the chances of dying from the disease. This study has attracted £1m in funding from AstraZeneca.

Professor Michael White (University of Liverpool): £5.1m from BBSRC (2008-2013)

Professor White's research has focused on the dynamics and function of the NF-κB signalling system. NF-κB is a protein complex that controls the transcription of DNA. It is found in almost all animal cell types and plays a key role in regulating the immune response to infection. Incorrect regulation of NF-κB has been linked to cancer, inflammatory and autoimmune diseases, septic shock, viral infection, and improper immune development. In conjunction with researchers at the Universities of Manchester and Warwick, Professor White has recently been awarded a grant from BBSRC to further this work with a systems approach to biological research (SABR). The project began in April 2008 and involves a multidisciplinary team of researchers. The work includes cell imaging, image analysis, gene expression analysis, bioinformatics, proteomics and phosphor-proteomics as well

as model-led data analysis, and mathematical modelling and simulation.

Professor Hazel Inskip (MRC Lifecourse Epidemiology Unit): £1.9m from the Nestle Research Center (2011-2013)

Professor Inskip's research has attracted an award from the Nestle Research Center to investigate epigenetics as a mediator of the early nutritional effects on human childhood body composition and the risk of humans developing obesity and insulin-resistance related disorders in later life.

Dr Alison Simmons (MRC Human Immunology Unit): £1.25m from the Sir Jules Thorn Charitable Trust (2011-2015)

The cytosolic sensor NOD2 is pivotal for defence against intracellular microbes. Variants in NOD2 are associated with inflammatory diseases such as Crohn's disease and infectious diseases such as leprosy. **Dr Simmons'** research looks at NOD2 signally to see how it directs the handling of microbes normally and in the presence of disease. She has been given a Sir Jules Thorn Award for Biomedical Research for the development of a high throughput discovery programme for druggable pathways in Crohn's disease.

Professor Chris Ponting (MRC Functional Genetics Unit): £1.9m from the European Research Commission (2010-2015)

Professor Ponting has been awarded a European Research Council Advanced Grant to study the functions and evolution of non-coding RNA genes. This interdisciplinary proposal will capitalize on new theoretical and experimental opportunities to establish the extent by which long non-coding RNAs contribute to mammalian and fruit fly biology.

Professor Declan Murphy(King's College London): €30m from the EU Innovative Medicines Initiative (2012-2017)

An MRC-funded group led by **Professor Declan Murphy** at King's College London is coordinating the largest award ever made to support research into therapies for autism. EU-AIMS (European Autism Interventions - A Multicentre Study for Developing New Medications)is led by Roche and Kings College and involves 14 centres of excellence across Europe. The award was made under the EU Innovative Medicines Initiative and totals almost €30million of funding from the public, private and charitable sectors.

Endnotes

1. http://www.hesa.ac.uk/
2. Estimates of further funding are based on the assumption that the spending is distributed evenly over the period reported. For example, if an investigator reported £100,000 of funding between 1 December 2011 and 1 December 2013, it is estimated that 50% of this award will have been spent in the period covered by this data gathering period.
3. The majority of the funding from Merck was awarded to the MRC/British Heart Foundation/Cancer Research UK Clinical Trial Service Unit. The Nokia investment was a single award to the University of Cambridge for research on nanotechnology. The GSK funding was however awarded across many different academic collaborations.

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MRC Medical Research Council

Outputs, outcomes and impact of MRC research: 2012 report

04: Next destination

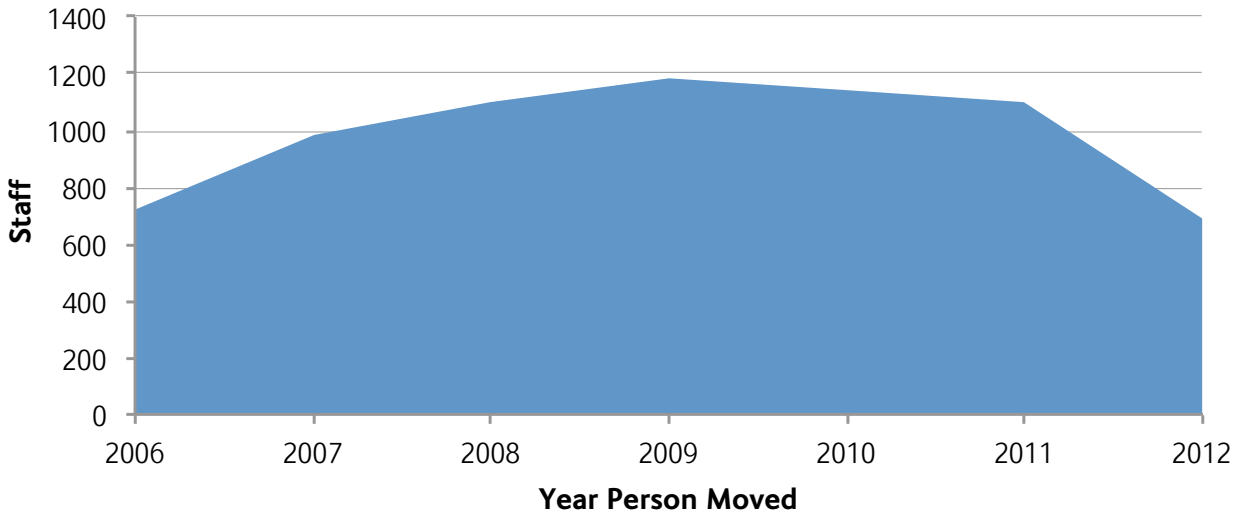
Next destination

Summary

The MRC is interested in tracking the career progression of those who leave MRC employment. Principal investigators reported details of staff who had left MRC support for 53 per cent of MRC awards. On average, there were three instances reported per award (for those awards where it was reported staff had left). Of the 6,953 reports of staff who moved from MRC support between 2006 and 2012[1] 22 per cent were research fellows and 12 per cent were research students. The numbers of staff for which next destination data was available peaked in 2009, at 1,170. Figure 1 shows the number of staff leaving MRC support by year. The data includes people leaving MRC awards that have terminated, people leaving for opportunities elsewhere or retiring, and people leaving fixed-term positions such as studentships.

The aim is to provide an overview of the flow of people each year into different sectors. It is reasonable to assume that these staff have benefitted to some extent from MRC funding in terms of training and expertise. In 2012, a further field to capture some specifics about any formal training gained by staff, during their time supported by the MRC, was added to Researchfish. In future, we will present analysis of the additional feedback received in this section[2].

Figure 1: Number of staff leaving MRC support by year



It should be noted that data for 2012 are partial.

Positions held at the MRC and future positions

34 per cent of staff leaving the MRC were in a post-doctoral position, 24 per cent held a researcher position and 22 per cent held a research fellow position. The distribution of all roles held is shown in figure 2.

The majority of next destinations for research students leaving the MRC were described as 'post-doctoral researcher' (54 per cent), followed by 'student' (14 per cent). A breakdown of next destinations of research students is shown in figure 3.

The majority of post-doctoral researchers left MRC support to take up a further post-doctoral position (52 per cent), followed by research fellow/project leader (15 per cent)[3]. A breakdown of next destinations of post-doctoral researchers is shown in figure 4.

Overall, 61 per cent of staff remained in the academic (university-based) sector. 10 per cent of leavers moved into the private sector. Figure 5 shows a breakdown of next destinations by sector.

These results are very similar to those published in 2010, with the exception of a one per cent change in the proportion of staff moving to the private sector. Although this change is very small, the trend from 2006 to 2012 shows that a smaller proportion of staff have moved to the private sector[4]. This may indicate that new positions have become increasingly harder to obtain in this sector.

Figure 2: The distribution of roles held by staff leaving MRC support between 2006 and 2012

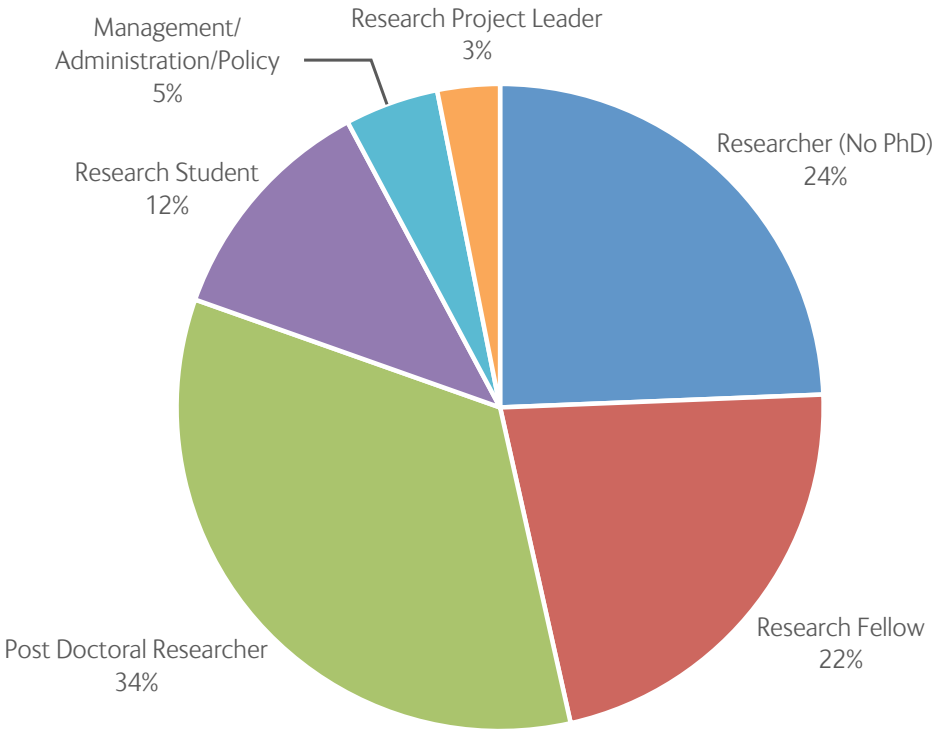


Figure 3: Next destinations of research students 2006-2012

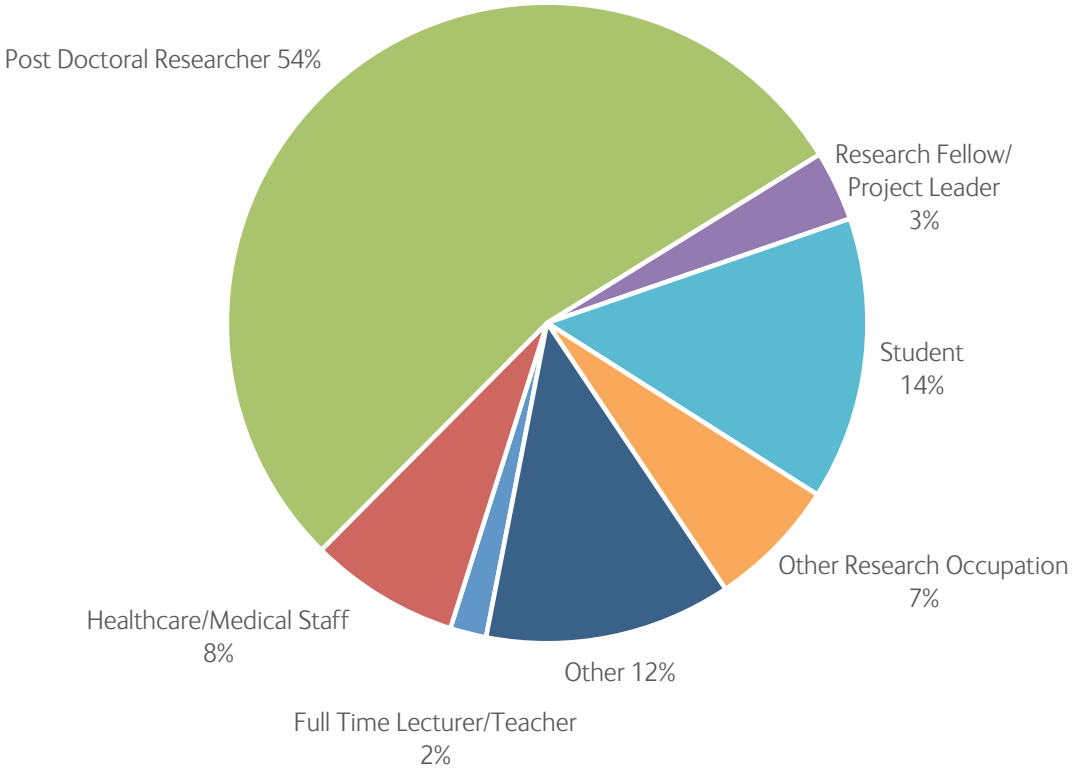


Figure 4: Next destinations of post-doctoral researchers 2006-2012

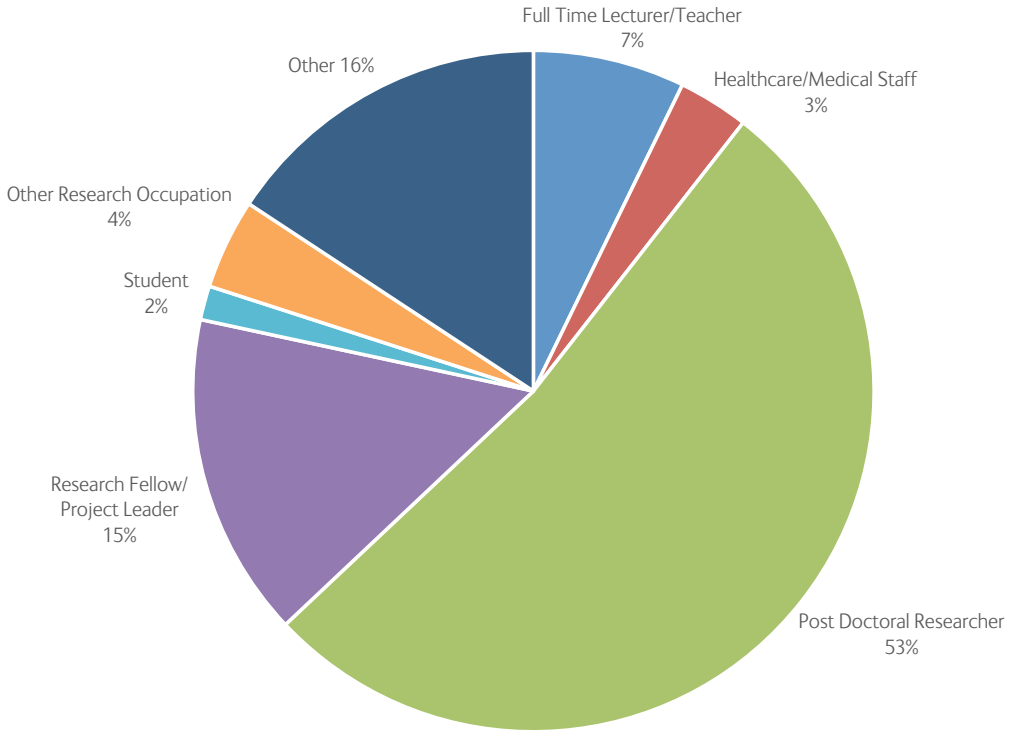
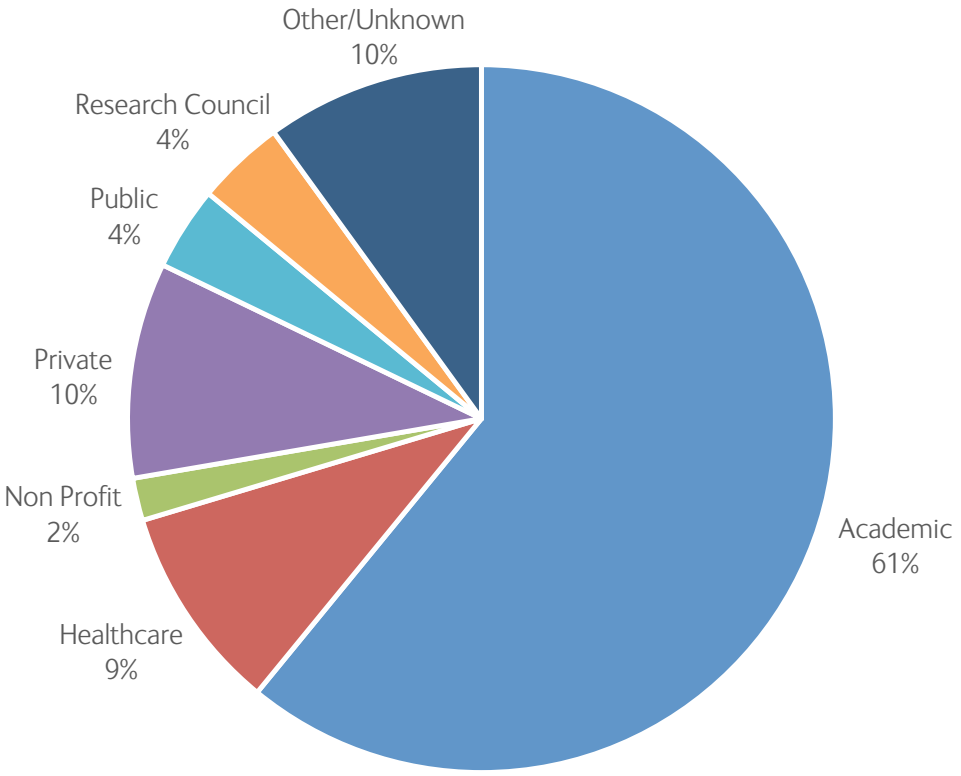


Figure 5: Next destinations for all team members by sector 2006-2012



Endnotes

1. Reported via Researchfish.
2. For example, in 2012, Researchfish captured feedback on 182 staff who had left MRC support having gained a PhD.
3. Discounting the 'other' category.
4. Each year further historical as well as current data is added to the dataset, and so the proportion of staff leaving for positions in the private sector has changed since 2010, but the trend is still downward from 10.5 per cent FTE posts in 2006 to 8.9 per cent of FTE posts in 2012. This contrasts with an upward trend for staff remaining in the academic sector (from 59.2 per cent to 63.1 per cent) and an almost unchanged proportion moving to the hospital sector (from 9.6 per cent to 10.1 per cent).

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MRC Medical Research Council

Outputs, outcomes and impact of MRC research: 2012 report

05: Engagement activities

Engagement activities

Summary

This section is focused on communication activities outside of those targeted at an academic audience. In the MRC e-Val pilot run in 2008, we discovered that approximately 75 per cent of scientific engagement activities involved scientific presentations to academic audiences (through, for example, lectures and seminars). Although it is imperative for researchers to share knowledge with the scientific community, it was decided not to focus on these activities in the interests of minimising the burden of data collection for researchers. However, when MRC e-Val became 'federated' as Researchfish in 2012, the requirements of other funders meant that four additional categories of 'audience type' (other academic audiences – collaborators and peers; postgraduate students; undergraduate students; supporters), and one further engagement type (scientific meeting) were added to this section. Researchfish provides the capability for researchers to populate CVs and in future may allow other re-use of output information (for example, population of grant application forms) so it is important that it is possible to record the full range of engagement activities. MRC researchers are, however, still advised that it is not necessary to report to the MRC engagement activities that purely involve the academic community, and this information is not included in the current analysis.

Dissemination of results beyond academia plays an important role in the research process. Engaging with non-academic audiences helps to enhance the understanding of complex topics, communicate the importance of research undertaken and inspire future careers in science.

- Researchers reported engagement activities outside of academia in 57 per cent of awards.
- The total number of engagement activities reported between 2006 and 2012 was 18,394.
- The average number of engagement activities per award (for awards reporting engagement activities) was seven (6.74).
- 10 per cent of all awards reported more than ten engagement activities. The number of engagement activities per award is shown in figure 1.
- There were 2,442 reports of engagement in 2012 alone. A breakdown of engagement activities per year is shown in figure 2.

Figure 1: Number of engagement activities per award

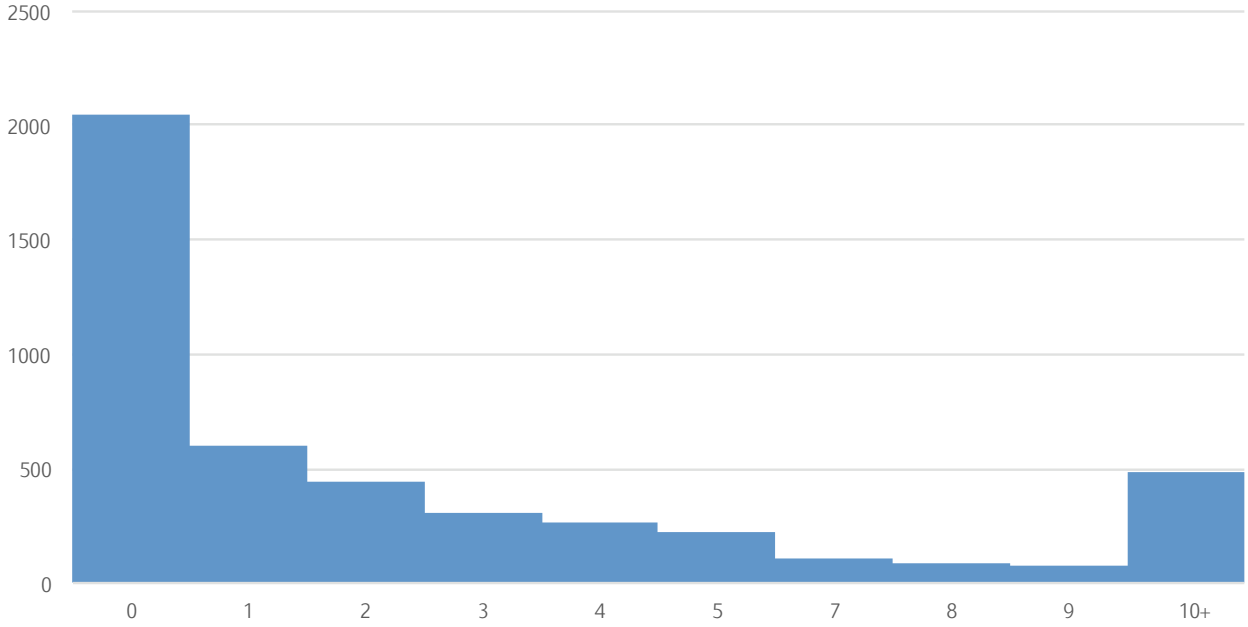
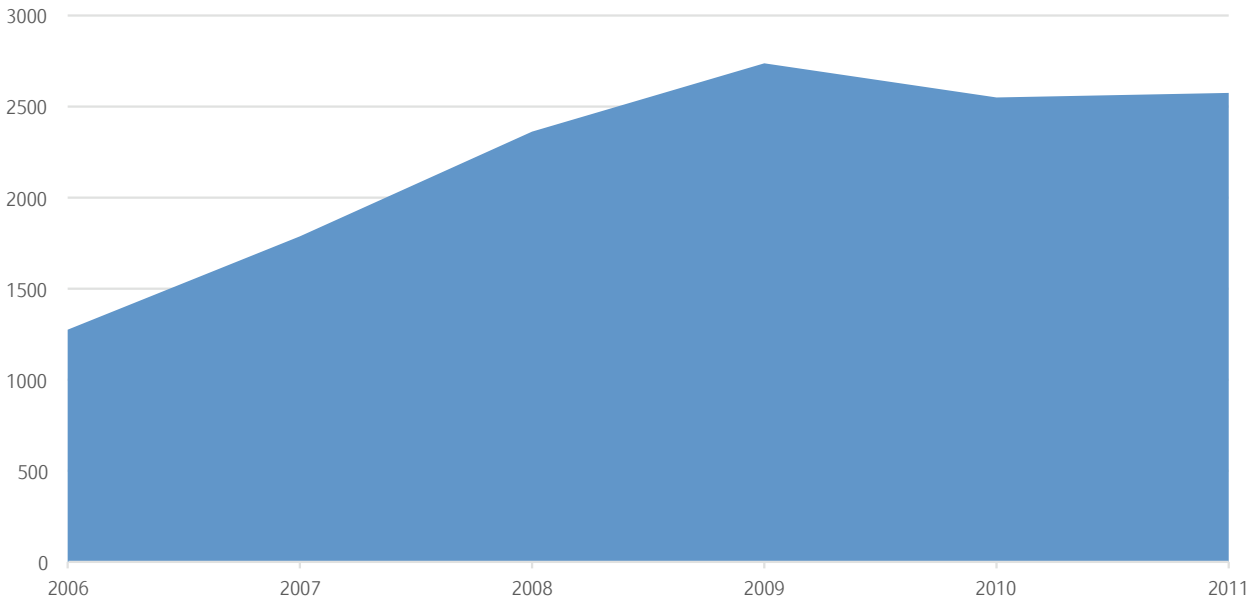


Figure 2: Number of engagement activities per year



Methods of engagement and audience type

The most popular method of engagement was a talk or presentation (39 per cent), followed by participation in an activity, workshop or similar activity (18 per cent). A breakdown of engagement activity by type is shown in figure 3.

The results are similar to the analysis undertaken in 2010 and the proportions of different engagement methods are fairly constant year-to-year, excluding the new category of scientific meeting (conference/symposium etc).

Around a third of engagement activities were aimed at the public or other audiences (5,306 instances – 37 per cent), while 19 per cent of engagement activities were aimed at health professionals, and 17 per cent were aimed at schools. A more detailed breakdown of audience type is provided in figure 4.

These results are similar to those published in 2010, with the exclusion of data relating to 'other academic audiences (collaborators/peers)'. In the first year of introducing this category, 1,500 instances (860 relating to 2012 alone) had been reported.

Figure 3: Engagement activity by type

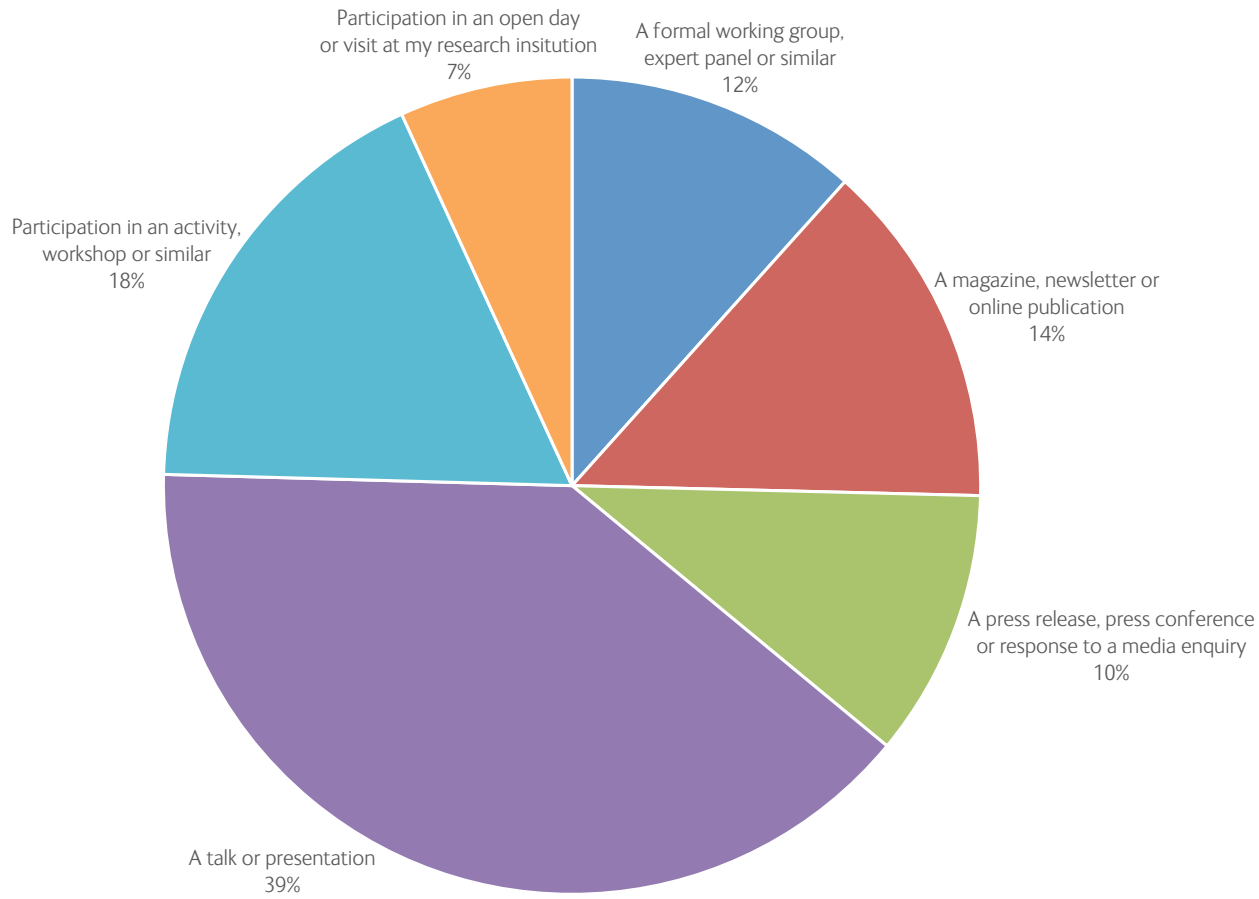
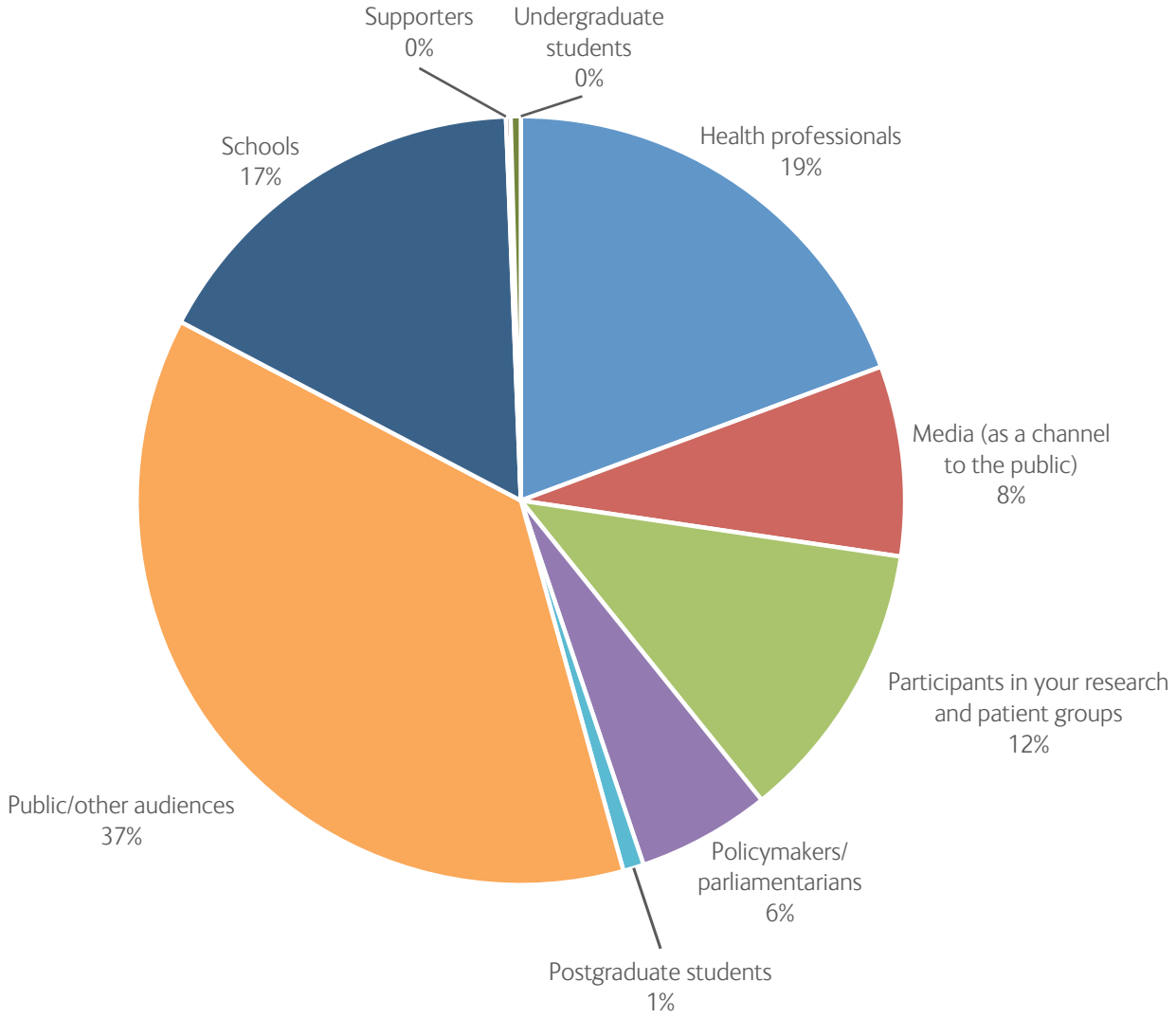


Figure 4: Engagement activity by audience



Selected examples of activities from MRC-funded researchers

Dr Aylwyn Scally (Wellcome Trust Sanger Institute)

Dr Aylwyn Scally was the lead author of the report "Insights into hominid evolution from the gorilla genome sequence"[1], published in March 2012, which detailed the mapping of the gorilla genome. This generated a large amount of media coverage, both nationally and internationally, including from the *BBC, The Guardian, The Daily Telegraph* and *CNN*.

Dr Roland Zahn (University of Manchester)

Dr Roland Zahn's research has shown that the brains of individuals with depression respond differently to feelings of guilt[2]. The research was published in Archives of General Psychiatry in June 2012, and generated national media coverage, which included articles in the *Daily Mail, The Times, Forbes, BBC* and *USNews*.

Dr Hashim Ahmed (University College London)

Dr Hashim Ahmed reported media coverage generated by his paper "Focal therapy for localised unifocal and multifocal prostate cancer: a prospective development study"[3]. This paper detailed the results of a clinical trial for a new type of prostate cancer treatment, using sound waves to selectively target individual cancer sites, which could provide an alternative to traditional

treatment with significantly fewer side effects. Media coverage included the *BBC*, *Sky News* and *The Times of India*.

Dr Sarah Skeoch (University of Liverpool)

Dr Sarah Skeoch is part of a network of female scientists (ScienceGrrl) whose aim it is to inspire the next generation of female scientists, technologists, engineers and mathematicians. In 2012, they launched a calendar featuring a wide range of female scientists from a diverse range of backgrounds, which sold over 900 copies. The work of the network has generated media coverage in several sources, including *The Guardian*.

Professor Tim Goodship (University of Newcastle)

Professor Tim Goodship has established a coalition group called aHUS Action which is campaigning for better NHS care for patients with atypical haemolytic uremic syndrome (aHUS), a rare disease causing acute kidney failure. Professor Goodship initiated an online e-Petition in 2012 which received 2,675 signatures and an Early Day Motion signed by 28 MPs.

Dr Donald Davidson (University of Edinburgh)

Dr Donald Davidson helped to develop 'Micromania' in 2011, an educational scientific children's game about infectious diseases, based on Happy Families.

Dr Kristien Boelaert (University of Birmingham)

Dr Kristien Boelaert gave a presentation to around 200 nurses in 2012 on updated guidance for the management of hyperthyroidism.

Professor Jonathan Friedland (Imperial College London)

Professor Jonathan Friedland hosted an annual study day from 2010 to 2012 for European Antibiotic Awareness Day addressing key issues relating to the role of nurses in antibiotic stewardship and infection prevention in an effort to improve patient safety, quality of care and the patient experience.

Schemes to support engagement activities

Researchers were asked to indicate whether their activities were supported by a recognised scheme – this was reported in 2,452 activities (16 per cent).

Selected examples of schemes reported by MRC-funded researchers

Royal Society MP-Scientist pairing scheme

This scheme builds links between parliamentarians, civil servants and some of the best research scientists in the UK. Participating scientists are paired with either an MP or civil servant and the Royal Society supports them by arranging a 'Week in Westminster' and reciprocal visits. The scheme aims to help MPs and civil servants establish longstanding links with practising research scientists and to help research scientists understand political decision-making and its associated pressures. The reported impacts included increasing MPs' awareness of particular medical research areas and issues, developing a research member's interest in the field of science policy, and the MP seeking further scientific advice from the institution.

I'm a scientist, get me out of here

This scheme is primarily funded by the Wellcome Trust and aims to promote science to school children aged 11-18 years by encouraging them to ask a team of young scientists about their work and science in general, and then vote for their 'favourite' scientist. The scheme was first piloted in 2008 and now runs twice a year. Researchers taking part in the scheme reported positive feedback from both teachers and school children.

Nuffield Research Placements

Nuffield Research Placements provide over 1,000 students each year with the opportunity to work alongside professional scientists, technologists, engineers and mathematicians. **Dr Rachael Rigby** (Lancaster University) hosted two students who spent four weeks in her laboratory working on their own science projects.

Endnotes

1. *Nature* 2012;483;7388;169-75
2. Guilt-Selective Functional Disconnection of Anterior Temporal and Subgenual Cortices in Major Depressive Disorder *Archives of General Psychiatry* 2012.
3. *Lancet Oncology* 2012 Jun;13(6):622-32

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Outputs, outcomes and impact of MRC research: 2012 report

06: Influence on policy

Influence on policy

Summary

The impact of certain areas of medical research is best demonstrated not by commercial exploitation but through the introduction of public health interventions and changes to policy. Data were collected on a variety of policy influences, from citations in clinical guidelines and reviews and the membership of guideline committees, to the participation in national consultations or an influence on the training of practitioners; the aim being to better understand the ways in which MRC research leads to impact.

MRC research has been instrumental in understanding the links between lifestyle and health, a specific example being the link demonstrated by MRC-funded research between smoking and health. Smoking cessation programmes have proved to be one of the most cost-effective and high-impact public health interventions ever introduced. The MRC continues to fund effective and innovative research in this area (see the case study 'MRC researcher develops new smoking cessation aid').

- MRC researchers reported 3,311 examples of influences on policy between 2006 and 2012.
- Once unique policy outputs have been identified, these reports can be divided into examples of citations in key policy documents (614 instances) or examples where researchers are directly involved in policy setting processes (2,292 instances)[1]. A breakdown of influences on policy documents by type and influences on policy setting processes by type is shown in figures 1 and 2.
- Influences on policy were reported in 23 per cent of awards. In these awards, the average number of reports was approximately three.
- There were 75 reports of citations in key policy documents in 2012. A breakdown of citations in policy documents by year is shown in figure 3.
- There were 338 reports of influences on policy setting processes in 2012. A breakdown of influences on policy setting processes by year is shown in figure 4.

Figure 1: Influences on policy documents by type

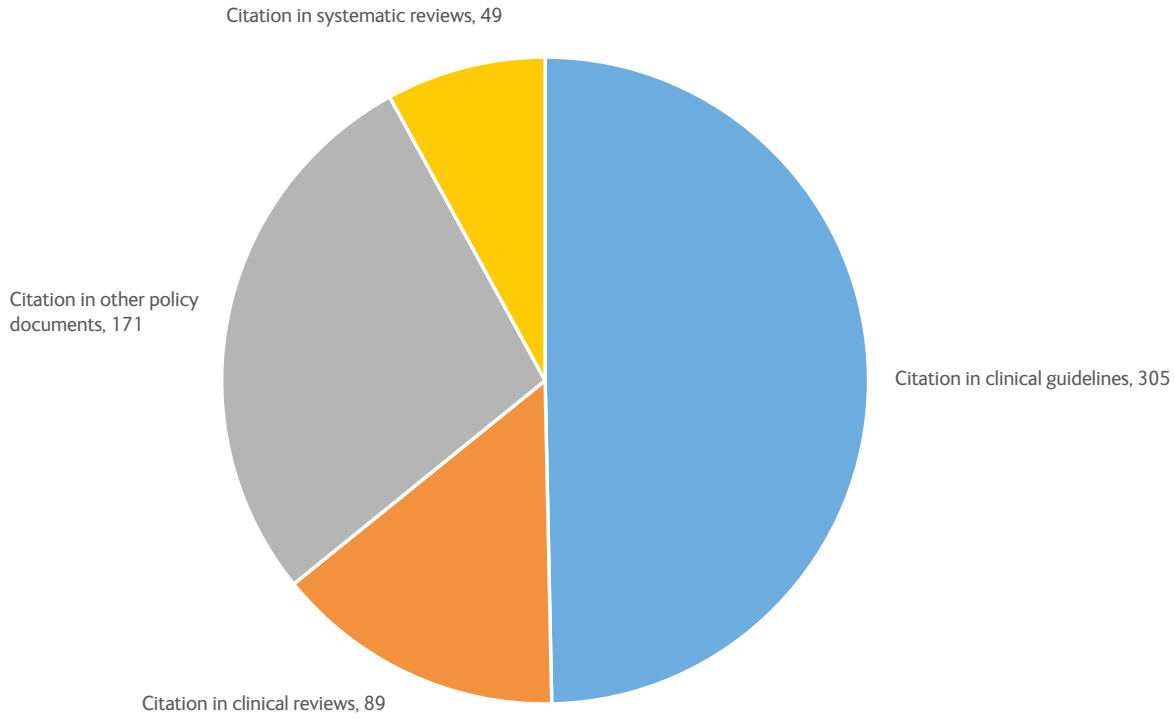


Figure 2: Influences on policy setting processes by type

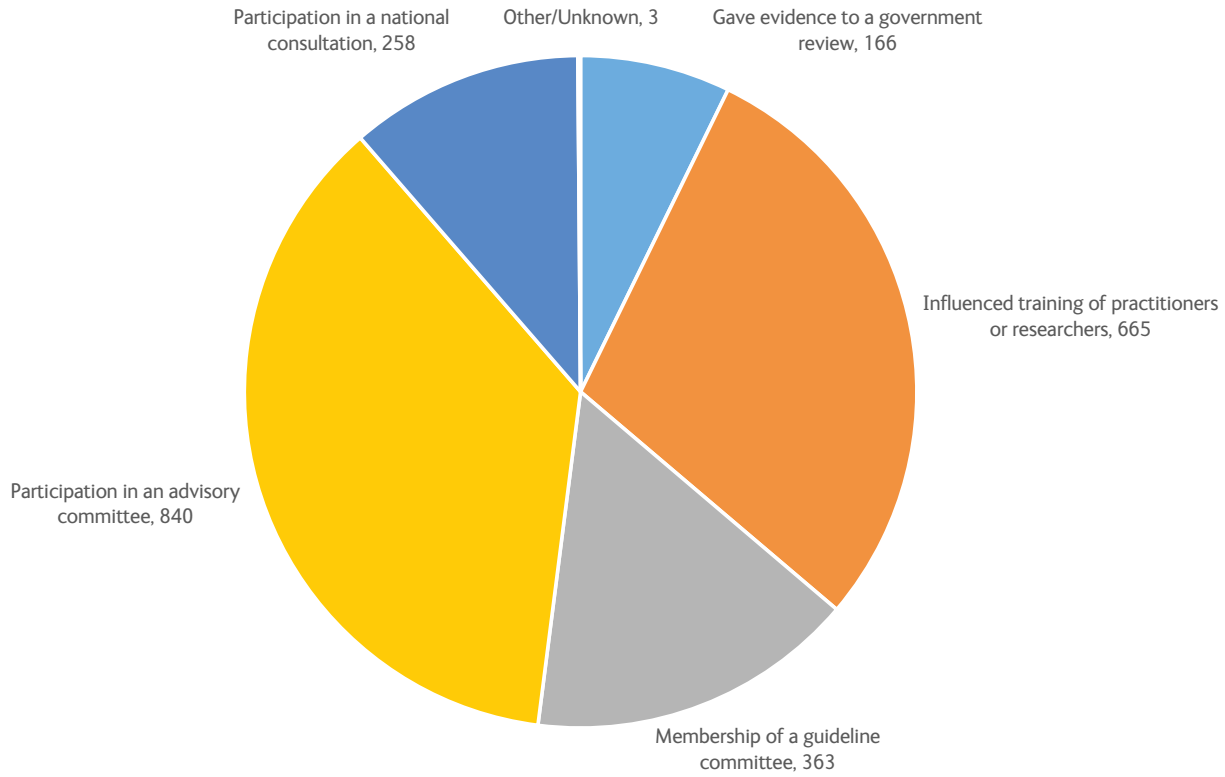


Figure 3: Citations in policy documents by year

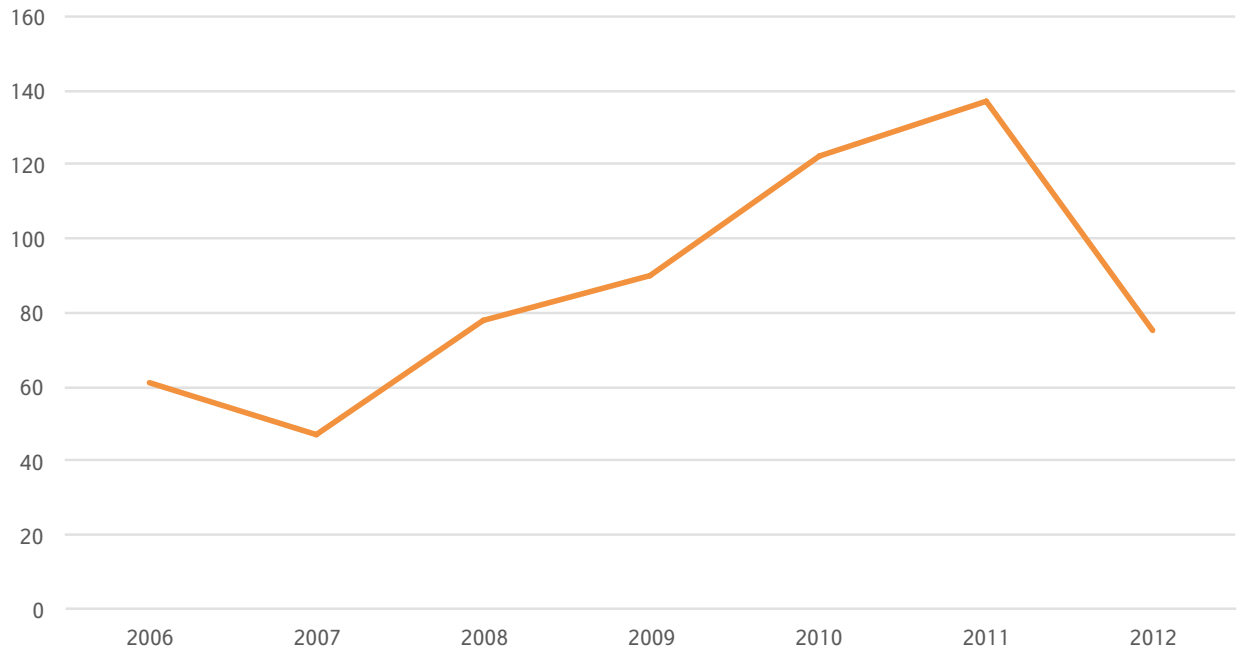
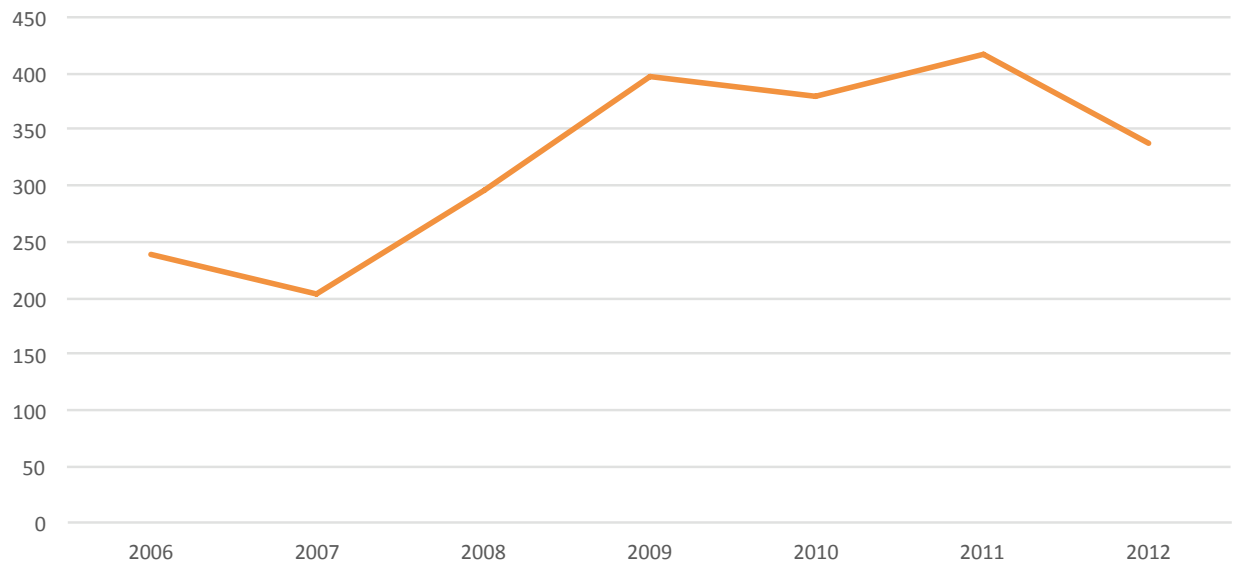


Figure 4: Influences on policy setting processes by year



There has been a general increase in the number of influences on policy from 2006. This is likely to be due to the increasing number of awards surveyed by Researchfish over the years, the length of time it takes for the output of an award to result in an influence on policy, and also in part due to continuing improvement in the comprehensiveness of reporting by researchers across the MRC portfolio.

The number of reports in 2012 is expected to be lower due to data-gathering taking place part-way through the year.

Citation in clinical guidelines

Clinical guidelines are statements that have been developed systematically and which aim to assist clinicians in making decisions about treatment for specific conditions, promoting 'best practice'.

Once the subject area for a clinical guideline has been identified and refined, a multidisciplinary expert group of key stakeholders systematically reviews all the available evidence. The group identifies and assesses relevant evidence around the subject, which is then translated into a useable and workable clinical form[2].

The MRC Researchfish dataset contains 305 reports of citations in clinical guidelines. These guidelines were issued by 84 different organisations; some examples of these, divided by geographical location, are shown below:

North America:	US Public Health Service American Psychological Association Institute of Medicine
UK learned and professional bodies:	British HIV Association Royal College of Obstetricians and Gynaecologists Royal College of Ophthalmologists
UK Government/public funders:	Medicines and Healthcare products Regulatory Agency (MHRA) NHS Screening Programmes
Europe	European Society for Medical Oncology European Centre for Disease Prevention and Control European Association of Urology
Asia	Asian Oncology Summit Consensus Group (AOSCG)

Selected examples of influences on policy

MRC research informs WHO guidelines on the treatment of tuberculosis (2010)

Dr Andrew Nunn at the MRC Clinical Trials Unit has played a pivotal role in developing the fourth edition of the World Health Organization (WHO)'s Treatment of Tuberculosis guidelines. His research has demonstrated that new pulmonary TB patients treated with a six-month rifampicin drug regimen experience a reduced number of relapses and failures when compared to those on a two-month regimen, alleviating patient suffering and conserving patient and programme resources[3]. The WHO has recommended discontinuation of the two-month regimen.

The recognition and initial management of ovarian cancer (2011)

Professor Mahesh Parmar (MRC Clinical Trials Unit) has contributed to the National Institute for Health and Care Excellence (NICE)'s first clinical guidelines for the detection, diagnosis and initial management of epithelial ovarian cancer[4]. Ovarian cancer has the highest mortality of any gynaecological cancer and kills about 4,300 women every year in the UK. Because the physical signs are not readily detectable and the symptoms are vague and non-specific, most cases are detected at advanced stages and have a very poor prognosis. One of the aims of the guidelines is to facilitate early diagnosis by increasing awareness of symptoms and signs.

Prevention of mother-to-child transmission of HIV and infant feeding (2010)

MRC-funded research[5] has contributed to the revision of WHO recommendations on the prevention of mother-to-child transmission (MTCT) of HIV. Mother-to-child transmission is the transmission of HIV from an HIV-positive mother to her child during pregnancy, labour, delivery or breastfeeding.

In the absence of any interventions, transmission rates range from 15-45 per cent. This rate can be reduced to levels below five per cent with effective interventions[6]. Significant progress is being made globally to prevent mother-to-child transmission of HIV, including in resource-limited settings. For the first time, the elimination of mother-to-child transmission is considered to be a realistic public health goal.

All HIV-infected pregnant women who are not in need of antiretroviral therapy (ART) for their own health require an effective Antiretroviral (ARV) prophylaxis strategy to prevent HIV transmission to their infants. **Dr Claire Townsend**'s (University College London) research has demonstrated that starting ARV prophylaxis earlier in pregnancy may be effective in further reducing MTCT. The WHO guidelines now recommend that ARV prophylaxis should start from as early as 14 weeks of gestation (ie during the second trimester of pregnancy), or as soon as possible thereafter.

MRC research identifies treatment in childhood motor neuron disease (2012)

Professor Henry Houlden at the MRC Centre for Neuromuscular Diseases, University College London, in conjunction with scientists at the National Institutes of Healthin the United States, has demonstrated that two riboflavin transporter genes are defective in children with a type of motor neuron disease called Brown-Vialetto-Van Laere (BVVL) syndrome.

Brown-Vialetto-Van Laere syndrome is a rare, neurological condition that attacks and progressively destroys motor neurons, causing paralysis of the cranial nerves. This results in the gradual deterioration of the body's functions, such as breathing, hearing, speech, movement, balance and heart function. The onset of disease is generally in infancy or adolescence. Many patients require a long term tracheostomy for ventilation and some never leave the intensive care unit.

The MRC's research has shown that defects in two genes coding for riboflavin transporters lead to a lack of riboflavin uptake in the cell and subsequent metabolic reduction. Treating children with high-dose riboflavin led to significant improvement in all aspects of their condition. Subsequent studies have since reported very promising results in BVVL patients who were given high doses of riboflavin supplements. There was evidence of stabilisation, and even reversal of degeneration, in some patients.

This is the first treatable cause of a type of motor neuron disease. Prior to this finding, treatment was restricted to supportive care.

MRC study shows that moderate drinking in pregnancy can affect a child's IQ (2012)

The MRC-funded Avon Longitudinal Study of Parents and Children (ALSPAC) has shown that moderate drinking during pregnancy can affect a child's IQ in what is believed to be the first substantial study of its kind. In contrast to previous studies where results have been conflicting due to the difficulty in separating the effects of moderate drinking from other lifestyle and social factors, ALSPAC used genetic variation to investigate the effects of drinking 1–6 units of alcohol per week among a large group of over 4,000 women. The researchers found four genetic variants in alcohol-metabolising genes among the children that were strongly related to a lower IQ at age eight. The child's IQ was on average almost two points lower per genetic modification they possessed. The Royal College of Paediatrics and Child Health has since advised mothers to drink no alcohol at all during pregnancy.

Prevention and management of neutropenic sepsis in cancer patients (2012)

MRC-supported researcher **Professor Robert Phillips** (University of York) was the clinical lead for the development of the NICE guidelines on neutropenic sepsis in cancer patients which took into account his research on optimising risk predictive strategies.

Neutropenic sepsis is a potentially fatal complication of anticancer treatment (particularly chemotherapy). Anticancer treatment suppresses the production of blood cells by the bone marrow; a low white blood cell count often leads to the development of fever, largely with other signs of infection in patients. Mortality rates ranging between two per cent and 21 per cent have been reported in adults. Aggressive use of inpatient intravenous antibiotic therapy has reduced morbidity and mortality rates and intensive care management is now needed in fewer than five per cent of cases in England[7]. However, a report by the National Confidential Enquiry into Patient Outcome and Death[8] and a follow-up report by the National Chemotherapy Advisory Group[9] highlighted problems in the management of neutropenic sepsis after receiving chemotherapy.

The new NICE guidelines provide evidence-based recommendations on the prevention, identification, risk-assessment and management of this condition.

MRC-funded research informs new NICE guidelines on the management of hypertensive disorders in pregnancy (2010)

MRC-funded research has shown antiplatelet agents to be effective in reducing the risk of developing preeclampsia. **Dr Jayne Tierney** (MRC Clinical Trials Unit) was part of an international collaboration that conducted a systematic review of individual patient data to assess the use of antiplatelet agents for the primary prevention of preeclampsia, and to explore which women were likely to benefit most. This directly influenced the recommendation relating to antiplatelet agents in the NICE guidelines on the management of hypertensive disorders in pregnancy.

Six to eight per cent of pregnant women will develop preeclampsia[10], characterised by high blood pressure and the appearance of protein in the urine. If left untreated, it can develop into eclampsia, the life-threatening occurrence of seizures during pregnancy. A study from one region of the UK reported that 1 in 20 women with severe pre-eclampsia or eclampsia were admitted to intensive care[11]. More recently, the long-term consequences for women with a diagnosis of hypertension during pregnancy have become clear, in particular chronic hypertension and an increase in lifetime cardiovascular risk. Hypertensive disorders also carry a risk for the baby. In the most recent UK perinatal mortality report, 1 in 20 stillbirths in infants without congenital abnormality occurred in women with preeclampsia.

Case studies

MRC research leads to new smoking cessation treatment (2012)

A 50-year study has shown that half to two thirds of all lifelong cigarette smokers will eventually die as a result of their habit[12]. Death is usually due to one of the three major diseases caused by smoking – lung cancer, Chronic Obstructive Pulmonary Disease (COPD) and coronary heart disease. Many who suffer from these diseases experience years of ill-health.

The cost to the NHS of treating diseases caused by smoking is approximately £2.7 billion a year[13].

In 2011, 63 per cent of smokers said that they would like to give up smoking altogether; however, 60 per cent of smokers felt that it would be either very or fairly difficult to go without smoking for a whole day.

The support provided by stop-smoking services has proved to be up to four times more effective than attempting to stop unassisted and twice as effective as the provision of a stop-smoking medicine, such as nicotine replacement therapy, by a healthcare professional[14].

In 2011, MRC-supported researcher **Dr Caroline Free**, from the London School of Hygiene and Tropical Medicine, led a team of researchers that developed txt2stop – a personalised support programme delivered by text message – and found it doubled quit rates[15]. The trial randomly divided 5,800 smokers who said they wanted to quit into two

groups: one receiving motivational quit-smoking text messages, and one receiving placebo text messages. About twice as many smokers who received the quit-smoking messages successfully quit after six months.

Participants in the txt2stop cessation programme received motivational text messages including, "Cravings last less than 5 minutes on average. To help distract yourself, try sipping a drink slowly until the craving is over." Participants in the control group received placebo messages that simply thanked them for participating, for example, "Thanks for taking part! Without your input, the study could not have gone ahead!".

After six months, 10.7 per cent of the txt2stop participants had stopped smoking compared to 4.9 per cent of the control group. Researchers verified the results by testing the saliva of participants who reported they had quit.

Following the publication of the trial results, Dr Free worked with the Department of Health in England to develop a new NHS service providing text message support for smoking cessation. Since the launch of the service in January 2012, more than 44,000 people have received text message-based smoking cessation support.

The results of the trial have led researchers in Sweden, USA, India and Italy, and the World Health Organization, to develop local smoking cessation support programmes delivered by text message.

MRC research leads to national bowel cancer screening programme (updated 2013)

There are one million new diagnoses of colorectal cancer (CRC) annually worldwide. It is the third most commonly diagnosed cancer and the second most frequent cause of cancer death in the UK. **It is estimated that it costs the NHS in excess of £1 billion annually.** Early diagnosis improves survival, and population-based screening reduces mortality.

In 2010, **Professor Wendy Atkin** (Imperial College London) published the results of an eleven-year trial funded by the MRC and Cancer Research UK (CRUK) that examined the effectiveness of a single flexible sigmoidoscopy at around age 60 in reducing CRC incidence and mortality[16]. The trial recruited 170,000 people aged 55-64 years from 14 UK regions, and invited one third (57,000) to have the screening test, with a 70% uptake rate.

In those who were screened, the cumulative incidence of cancers in the rectal and sigmoid colon, including prevalent cancers detected at screening, was reduced by 50 per cent, and by 33 per cent for bowel cancer overall. Bowel cancer mortality was reduced by 43 per cent. The trial concluded that flexible sigmoidoscopy screening with removal of small polyps at examination is safe and, when offered only once between the ages of 55 and 64, confers a substantial and long lasting benefit.

Following publication of the results, the UK Government announced a £60 million investment in a flexible screening programme. Alongside the main findings, Professor Atkin's research team developed a fail-safe, efficient, patient-friendly delivery system for FS screening, and a surveillance strategy following adenoma-removal. From March 2013, the NHS Bowel Screening Programme will pilot the flexible sigmoidoscopy screening test in six bowel screening centres around the country, inviting men and women at the age of 55 in for testing. It is planned to roll out the programme to everyone in the country aged 55 by 2016.

Type 2 diabetes (updated 2013)

Diabetes mellitus type 2 is a metabolic disorder that is characterised by high blood glucose in the context of insulin resistance and relative insulin deficiency. Rates of type 2 diabetes have increased markedly over the last 50 years in parallel with obesity. Since 1996, the number of people in the UK diagnosed with diabetes has more than doubled from 1.4 million to 2.9 million. By 2025, it is estimated that five million people will have diabetes[17].

In the UK, the cost to the NHS of treating type 2 diabetes and its complications in 2010 was £11.7 billion[18], approximately 10 per cent of the total NHS budget.

The Department of Health (DH) asked the National Institute for Health and Clinical Excellence (NICE) to produce public health guidance on the prevention of type 2 diabetes mellitus among high-risk groups, which was published in 2011. Expert testimony was taken from:

- 'Type 2 diabetes and pre-diabetes: diagnosis and definition' by **Professor Nick Wareham**, MRC Epidemiology Unit.
- 'BME groups, diet and risk of type 2 diabetes' by **Dr Nita Forouhi**, MRC Epidemiology Unit.
- 'Dietary strategies for the prevention of pre-diabetes' by **Dr Susan Jebb**, Medical Research Council Human Nutrition Research.

MRC-funded **Professor Doug Turnbull** also contributed to the advice given on lifestyle interventions in the prevention of type 2 diabetes.

The MRC has funded the establishment of MoveLab[19] at Newcastle University to undertake research relating to the link between ageing, metabolic disease, neuromuscular disease and physical activity. A recent trial has proven that by just moving around more, patients with type 2 diabetes can achieve better blood glucose control and delay the need for additional medications like insulin. This has led to the development of Movement as Medicine, the UK's first professional development pathway for physical activity in the management of type 2 diabetes. This programme will be delivered across primary care practices in the North East of England.

MRC research informs new NICE guidance on the management and support of children and young people on the autism spectrum (2011)

MRC-supported scientist **Professor Jonathan Green** (University of Manchester) sat on the autism in children and young people NICE Guidelines Development Group. His Pre-school Autism Communication Trial (PACT) has influenced the development of new NICE guidelines for the management and support of children and young people on the autism spectrum (in development 2013)[20].

PACT, which ran from 2006-2010, made an important contribution to the growing evidence around treatments for autism. It tested a parent-mediated communication-based intervention for young children with autism. The trial was a major scientific success and constitutes one of the largest autism intervention studies completed internationally[21]. The study recruited 152 families with children with autism between the ages of two and five years across the three sites (Manchester, Newcastleand London). Half of these families were randomly allocated to attend PACT therapy sessions over the course of 12 months. The study found that parents who took part in the PACT therapy sessions

were successful at adapting their style of interacting with their child and in turn their child communicated more with speech and gestures with their parent. These parents also reported improvements in their child's language abilities. Many children in both groups showed improvements in their communication and social interaction over the course of the 13 months, as measured by the play-based Autism Diagnostic Observation Schedule (ADOS) assessment.

Endnotes

1. A particular example of an influence on policy might have been reported by more than one researcher and so these outputs are de-duplicated in analysis of the type of outputs generated; this is the reason that the total numbers of policy types do not equal the number of reports.
2. Samanta A et al, Legal considerations of clinical guidelines: will NICE make a difference? J R Soc Med. 2003 March; 96(3): 133–138.
3. WHO guidelines: The Treatment of Tuberculosis http://www.who.int/tb/publications/2010/9789241547833/en/
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9. Chemotherapy services in England: ensuring quality and safety (2010)
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13. Callum C, Boyle S, Sandford A. Estimating the cost of smoking to the NHS in England and the impact of declining prevalence. Health Economics Policy & Law 2010
14. Smoking Toolkit Study – www.smokinginengland.info
15. Smoking Cessation Support Delivered Via Mobile Phone Text Messaging (txt2stop): A Single-Blind, Randomized Trial. The Lancet 2011 Vol. 378, No. 9785.
16. Atkin, W et al, Once-only flexible sigmoidoscopy screening in prevention of colorectal cancer: a multicentre randomised controlled trial. The Lancet, Volume 375, Issue 9726, Pages 1624 - 1633, 8 May 2010
17. http://www.diabetes.org.uk/Documents/Reports/Diabetes-in-the-UK-2012.pdf
18. Kanavos, van den Aardweg and Schurer: Diabetes expenditure, burden of disease and management in 5 EU countries, LSE (Jan 2012)
19. http://movelab.org/
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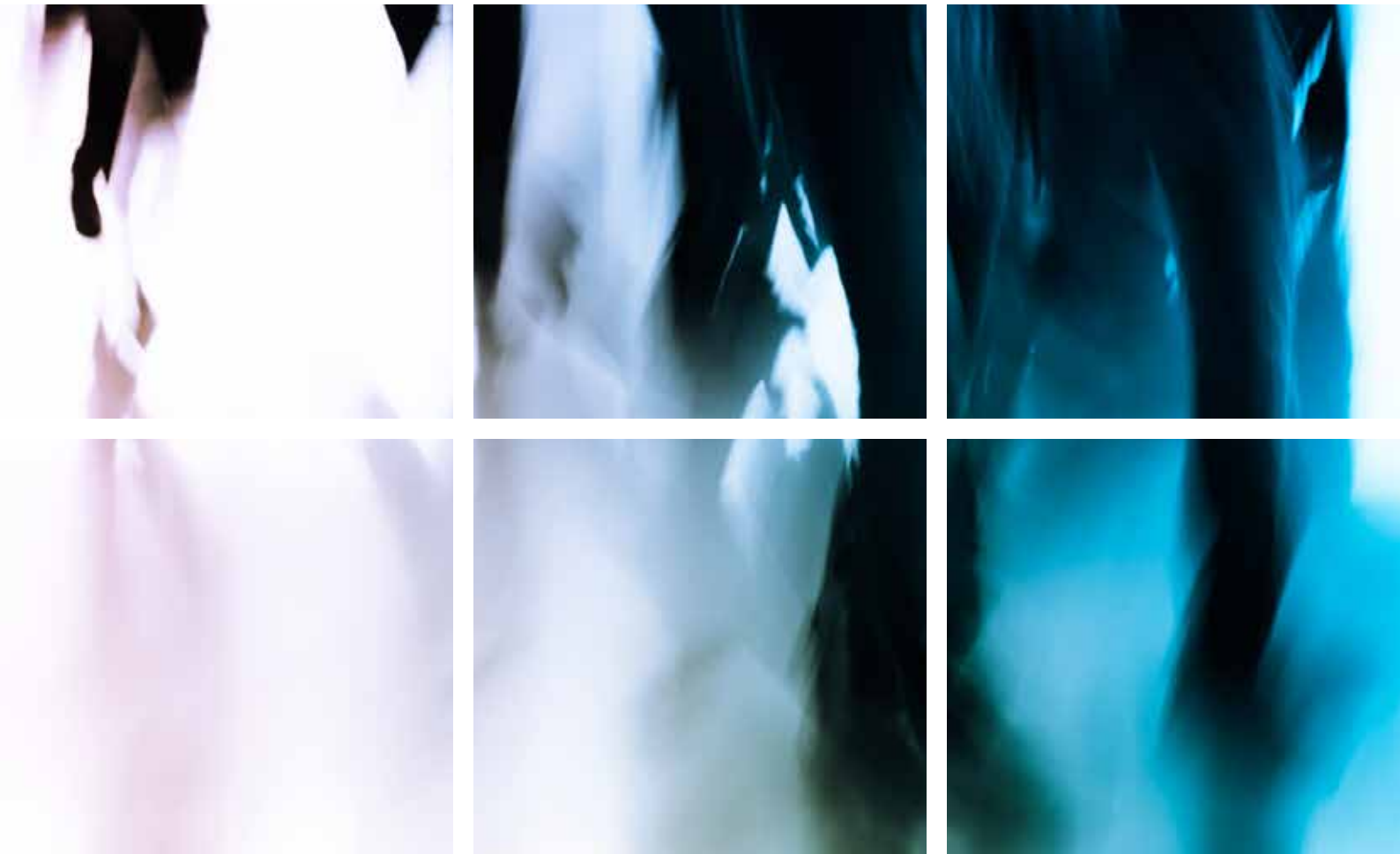
21. Green, J., Charman, T., McConachie, H., Aldred, C., Slonims, V., Howlin, H., Le Couteur, A., Leadbitter, K., Hudry, K., Byford, S., Barrett, B.,Temple, K., Macdonald, W., Pickles, A., and the PACT Consortium. (2010). Parent-mediated communication-focused treatment in children with autism (PACT): a randomised controlled trial. The Lancet, 375(9732), 2152-2160

researchfish

MRC Medical Research Council

Outputs, outcomes and impact of MRC research: 2012 report

07: Research materials



Research materials

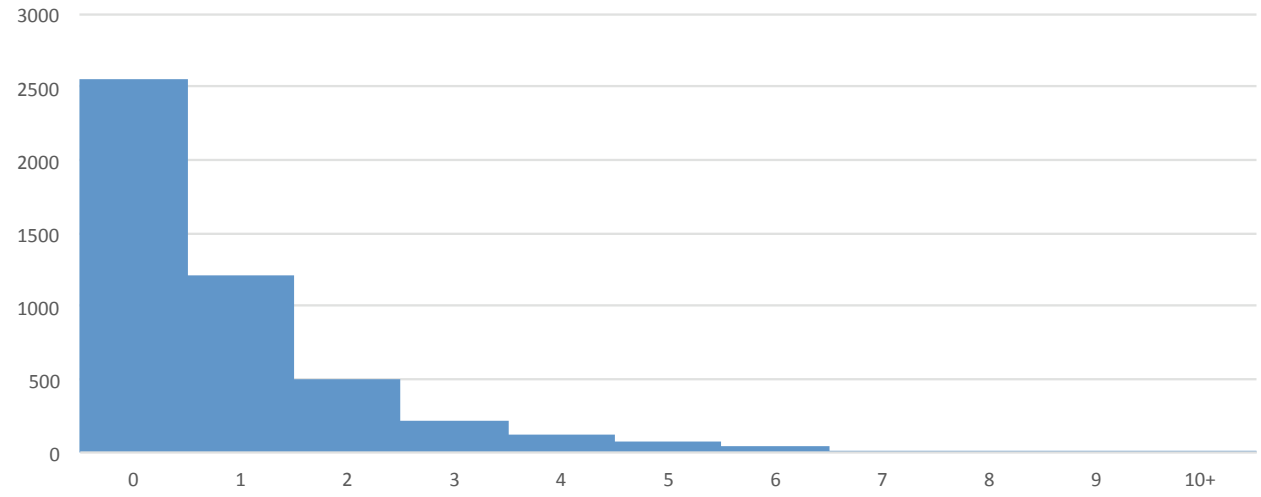
Summary

Information was sought on new research materials, whether these had been shared with others, and if there was evidence that these had supported new lines of enquiry. In particular, we were interested in the new models, methods, databases, reagents, technologies and techniques that are transforming research.

Recipients of 46 per cent of awards reported that their work had produced research materials for others to use. 5,226 reports detailing research materials were entered in Researchfish in 2012. This is an encouraging increase on the figure of 4,029 entered in 2011.

The average number of research materials reported per award (of those awards for which research materials were recorded) was two (2.36). The distribution of research materials per award is shown in figure 1.

Figure 1: Number of research materials per award

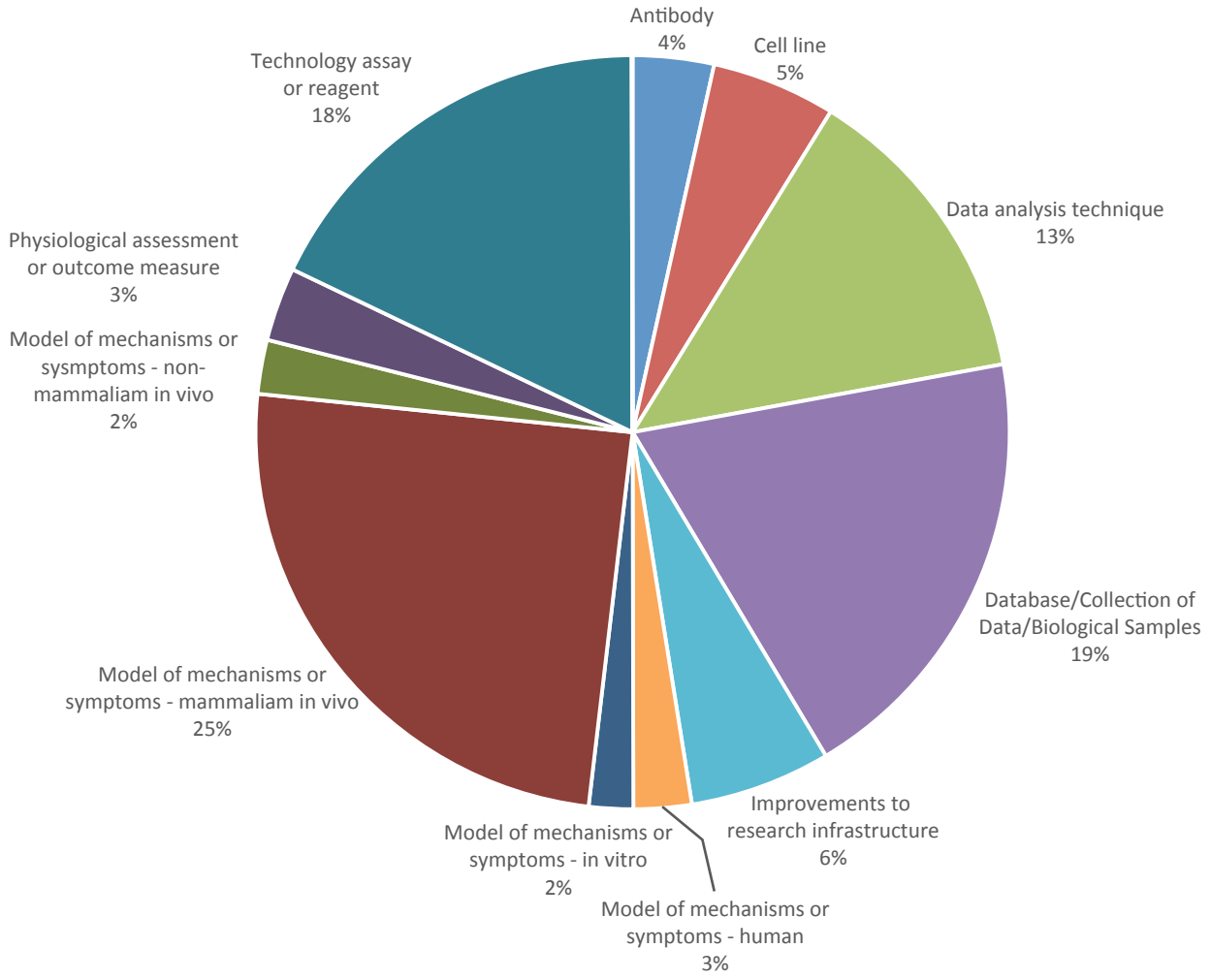


Type of research material

Models of mechanisms or symptoms – whether mammalian in vivo, non-mammalian in vivo, human or in vitro - were the most common research material (32 per cent). Figure 2 shows a breakdown of the distribution of type of research materials reported.

It is worth noting that material in this section often referred to results that had led to address positively the reduction, refinement or replacement (3Rs) of the use of animals in research. Examples of research materials where these developments are relevant to the 3Rs are listed at the end of this section.

Figure 2: Research materials by type



Selected examples of research materials, tools and technologies

PlasmoGEM resource and database
(Wellcome Trust Sanger Institute, 2012)

Dr Oliver Billker has developed the Plasmodium Genetic Modification Project (PlasmoGEM), which uses a combination of recombineering and the Gateway cloning system to convert genomic libraries into gene targeting vectors. Significant improvements have been made to the genetic system of Plasmodium berghei, a model parasite infecting rodents, by overcoming the challenges of manipulating large fragments of AT-rich parasite DNA in E.coli. This has enabled the development of a production pipeline for highly efficient genetic modification vectors at genome scale, which in turn led to the production and free dissemination of a community resource of genetic modification tools for P.berghei, supported by a public database[1].

Neighbourhood systematic observation via Google Earth
(King's College London, 2010)

Professor Terrie Moffitt has developed a coding scheme and training materials to enable the use of Google Earth to observe research participants' physical environments, in order to better understand the link between a child's environment and health. This has so far been adopted by other research groups in the UK, Australia, Finland, and the USA.

Discovery of gene mutation and development of new mouse model
(University of Cambridge, 2010)

Professor Anthony Green's discovery of a JAK2 gene mutation has resulted in a new molecular classification of the myeloproliferative neoplasms, a group of diseases of the bone marrow, in which excess cells are produced. Several diagnostic tests (for the JAK2 and other mutations) have been developed, which are now in routine diagnostic use. A mouse model of the disease has also been developed. These studies have had a direct clinical impact with new approaches to classification and diagnosis which are already embedded in international guidelines.

TRANSORCE Bank
(MRC Clinical Trials Unit, 2011)

TRANSORCE is a phase 3 randomised double-blind study comparing drug Sorafenib with a placebo in patients with a resected primary renal cell carcinoma at high or intermediate risk of relapse, led by **Professor Richard Kaplan**. Studying the blood and tissue samples collected from consenting patients has enabled the identification of a gene associated with the risk of developing renal cancer.

New mouse model for cardiac disease
(University of Manchester, 2011)

Pak1 is a key member of a highly conserved family of serine-threonine protein kinases (Pak family). **Dr Min Lei's** team has recently established that the Pak1 regulatory pathway is central to the regulation of cardiac excitation and contraction and Pak1 activation prevents cardiac ischemic/reperfusion injury and its associated arrhythmias. A mouse model carrying a cardiomyocyte-restricted deletion of Pak1 has been developed to enable further study.

Mouse model for dementia gene
(MRC Prion Unit, 2012)

Dr Adrian Isaac's team has discovered that a mutation in the CHMP2B gene causes frontotemporal dementia, the second most common type of presenile dementia after Alzheimer's disease. The team has demonstrated that CHMP2B is required for a process of cell degradation called autophagy. They have generated CHMP2B knockout mice and transgenic mice expressing mutant and normal forms of human CHMP2B for further study.

epiLab-SS (TCa)
(University College London, 2012)

Professor Carol Dezateux reported the development and certification of a secure cloud Virtual Desktop Infrastructure (VDI) environment to be used as a service for the management of sensitive or identifiable data. This is the first service of its kind in the UK, offering a scalable model of secure data processing in a private cloud, paving the way for better integration of data with the NHS and other government agencies.

Selected examples of research materials with relevance to the 3Rs

Human dental pulp stem cell line
(Cardiff University, 2010)

Professor Alastair Sloan reported the development of a human dental pulp stem cell (DPSC) line. His research has focused on the functional behaviour of the dental pulp stem cells and how these cells may be manipulated to facilitate dentine and bone regeneration. The establishment of a human cell line has negated the need for isolation from animals (mice).

Zebrafish models of human disease
(MRC Human Genetics Unit and MRC/Sheffield University Centre for Developmental and Biomedical Genetics, 2008-2012)

The zebrafish is currently the pre-eminent non-mammalian vertebrate species for modelling human disease processes. Up to the growth stage at which zebrafish larvae begin to feed, this model is not regulated under the Animals (Scientific Procedures) Act, and zebrafish are of considerable reduced neurophysiological sensitivity compared to rodents. These systems also allow experiments not possible in other model systems.

MRC funding has developed a high throughput system for screening drugs using zebrafish[2], development of an epilepsy zebrafish model[3], cancer models in zebrafish[4], and established a zebrafish larval model of inflammation[5].

Axolotl embryo models for stem cell development
(University of Nottingham, 2010)

Professor Andrew Johnson has developed axolotl (Mexican salamander) embryos as a model system and demonstrated that the mechanisms governing pluripotency are conserved, from urodele amphibians (salamanders) to mammals[6]. Importantly, axolotls express an ortholog of a gene, Nanog, which is a master regulator of pluripotency, but it is not found in either xenopus or zebrafish. The group is therefore in the unique position of being able to unpick the early molecular events that govern the establishment of pluripotent cells. This is anticipated to have a major impact on understanding how to direct the cell-specific differentiation of pluripotent embryonic stem cells from mammals. This work has in part led to the formation of the University of Nottingham spin out company EvoCell Ltd (see chapter 10 - Spin outs).

Pond snail as a model organism
(University of Sussex, 2010)

Professor George Kemenes has established the pond snail (Lymnaea) as a model system[7] to analyse evolutionarily conserved fundamental molecular and cellular mechanisms of memory function and dysfunction[8]. Studies at the molecular level might otherwise be performed on organisms regulated under the Animals (Scientific Procedures) Act. This work has been continued and expanded with BBSRC funding[9].

New mouse model for CNV
(University College London, 2012)

Choroidal neovascularisation (CNV) is the development of new blood vessels in the retina, and is a common symptom of age-related macular degeneration. The condition is often modelled by inducing this growth using lasers. **Dr Eric Ng** has used a novel mouse model which develops the condition spontaneously and found that this is more consistent. The advantage is that these studies do not require the invasive laser procedure, and yield better quality data. This means both a refinement in the use, and reduction in the number, of animals needed for the work. The consistency of CNV observed in the model has opened up the potential to study vascular endothelial growth factor (VEGF) as a treatment.

New cage systems for monitoring movement and feeding
(University of Cambridge, 2012)

Professor Antonio Vidal-Puig's work has led to a refinement of metabolic cages for monitoring movement and feeding in mice[10]. The new caging system allows simultaneous assessment of food intake, energy expenditure, activity, and water consumption. The equipment incorporates novel features such as having a food delivery system hook on the cover of the cage. The newly developed system to assess energy balance is also a refinement because more accurate measurements can be made in each experiment. The addition of a 24h camera system with Visual Sonics software enables secure systems to observe without interfering with measurements.

ADHD mouse model
(University College London, 2011)

Dr Clare Stanford and **Professor Hugh Gurling** established the NK1R-/- mouse model of ADHD[11] which has advanced approaches to the behavioural phenotyping of mutant mouse models and evaluation of their neurochemical status. These advances mean higher quality information is obtained from experiments, reducing the number of experiments required.

Simultaneous imaging
(University of Sheffield, 2010)

Professor Peter Redgrave and **Dr Jason Berwick** have developed a methodology to allow simultaneous brain imaging with either 2D- optical imaging spectroscopy or Laser Doppler flowmetry in rats[12], thereby reducing the numbers of animals required.

New cell lines
(University of Oxford, 2011)

Professor Vincenzo Cerundolo and colleagues have generated mammalian cell lines that over express the scavenger receptor SCARA5 in an inducible way. These are thought to play a role in the immune activity of epithelial cells. Being able to investigate the biological activities of this novel receptor in vitro has led to a reduction in animal usage.

New microfluidics system
(MRC Laboratory of Molecular Biology, 2008)

Work in **Dr Alexander Betz's** lab is focused on analysing the adaptive immune response. Development of a novel microfluidics system to isolate and analyse primary cell cultures has led to a reduction in the numbers of animals used in this work.

Use of the minipig for corneal grafts
(University of Bristol, 2012)

Dr Susan Nicholls has refined approaches in the use of the minipig as a model for corneal graft rejection. Her group have evaluated, and improved, on protocols, such as socialising pigs with research personnel before transplantation to minimise the stress of essential peri-operative interventions and to maximise their success[13], also reducing the number of pigs required.

Endnotes

1. http://plasmogem.sanger.ac.uk
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researchfish

MRC Medical Research Council

Outputs, outcomes and impact of MRC research: 2012 report

08: Intellectual property

Intellectual property

Summary

In this section, researchers reported details of discoveries that have been, or are in the process of being, shared with others. Several routes may be taken to recognise these discoveries as the intellectual property of particular inventors to ensure that the originator is acknowledged, or that rights to commercialise are protected.

Researchers reported, via Researchfish, the registration of a design or trade mark, assertion of copyright (in the case of authorship), or whether they had simply protected 'know how' using confidentiality agreements. We also asked for information about published patents. Patents are intellectual property rights granted by a country's government as a territorial right for a limited period. It is important that the process of securing a patent is not jeopardised by disclosing details of the discovery before the filing of the patent is formally published. This is why Researchfish requests information about patents from the stage of publication. Patents generally cover products or processes that contain 'new' functional or technical aspects. They are concerned with how things work, how they are made, or what they are made of. Following publication of the patent application, the patent may be formally granted. Applicants then have to pay to maintain the patent in each territory.

By matching the patent details provided via Researchfish with the European Patent Office (EPO) database (Espacenet), we can gather information about whether applications have progressed to being granted, or whether applications were abandoned, and whether granted patents are maintained.

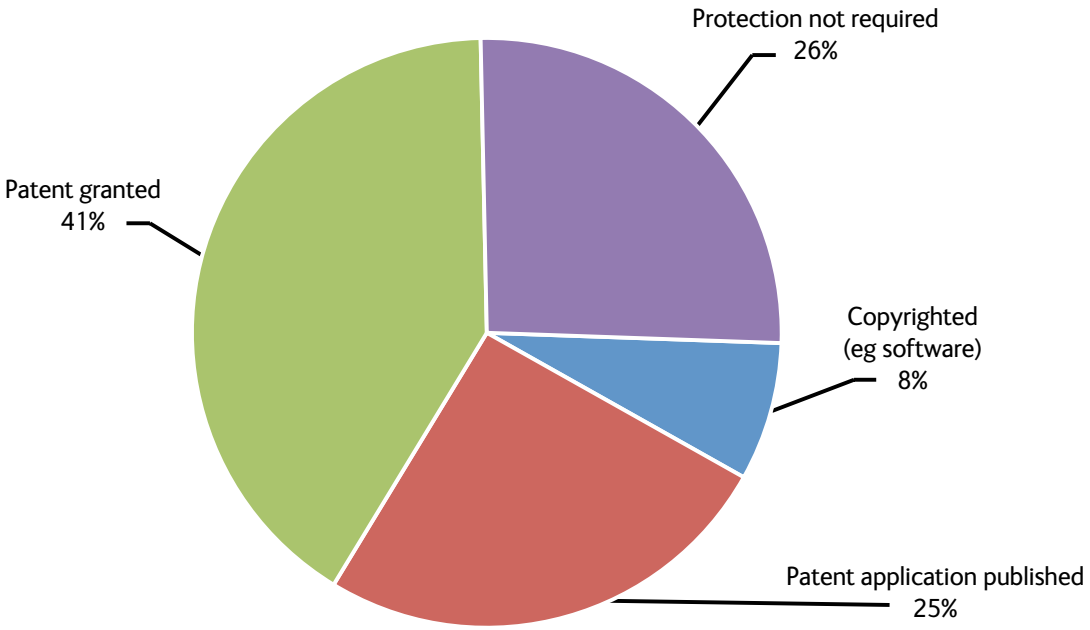
The MRC is particularly interested in whether discoveries have passed the first market test of being licensed to someone else. The terms of these licenses are usually confidential, so Researchfish simply focuses on capturing whether researchers could report that their intellectual property had been licensed or not, and whether there was anything to report on subsequent impacts.

Volume and type of intellectual property generated by MRC research

The MRC dataset contains details of 869 discoveries in the intellectual property section. These include 66 reports of copyrighted works, 225 reports of discoveries for which formal protection was not possible or required, and 578 reports relating to published and granted patents.

In almost half of all reports (41 per cent), the patent had already been granted. Figure 1 gives a breakdown of the type of intellectual property reported.

Figure 1: Type of intellectual property reported

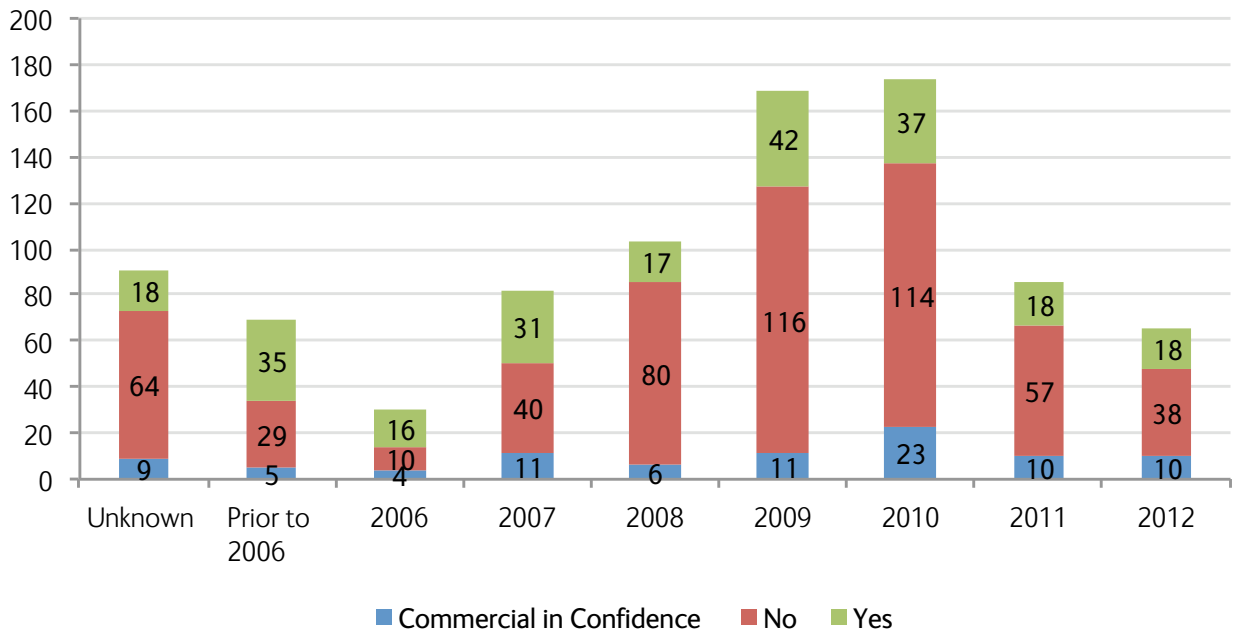


Licensing of intellectual property

26 per cent of discoveries overall (232/869) were reported as 'licensed' by 2012. The proportion is slightly higher for patented discoveries (31 per cent, 180/579). This is similar to the proportions reported in the last two years, and in our previous report from 2010, we suggested that this seemed reasonable in light of similar data from other organisations[1]. This calculation does not include the 10 per cent of reports where researchers indicated that details were 'commercial in confidence' and could not be provided (89/869); it would be reasonable to assume that some of these cases will translate into new licenses in due course.

Figure 2 shows the distribution of intellectual property licensing by year of publication.

Figure 2: Numbers of all reports of intellectual property licensed/not licensed/commercial in confidence, by year of publication



Selected examples of non-patented intellectual property

MRC researchers reported a wide variety of non-patented technologies, methods and other materials that were being actively exploited by others, whether under agreements that provided free access to academics, or licenses that return revenue from commercial partners.

A Tiny Handbook of R

Members of the MRC/University of Edinburgh Centre for Cognitive Ageing and Cognitive Epidemiology (CCACE) have written "A Tiny Handbook of R" (a software package for statistical analysis), published by Springer in 2011. The book has sold over 170 copies and is being used in a course on Data Analysis, Forecasting and Risk Analysis run at Washington University, St Louis.

Cancer DNA copy number

MRC New Investigator grant holder **Dr Christopher Yau** (Imperial College London) has developed software that allows DNA copy number alterations to be determined from single nucleotide polymorphism data arising from microarray analysis of cancer samples. Extensions to the OncoSNP software have been incorporated into a successful Wellcome Trust/Department of Health, Health Innovation Challenge Fund application (HICF-1009-026).

Computerised Interactive Remediation of Cognition – Training for Schizophrenia (CIRCuiTS)

CIRCuiTS has been developed using MRC Developmental Pathway Funding Scheme funds awarded to King's College London. It is a novel computerised psychological therapy for people with a diagnosis of schizophrenia which aims to improve thinking skills such as attention, memory and problem-solving. It is being tested in a phase 3 trial (ISRCTN55488371), has been translated into other languages, and is available free for further development in clinical trials across the world.

Physical Activity and the Regeneration of Connswater (the PARC study)

The Connswater Community Greenway is a major environmental improvement project in East Belfast connecting 379 acres of public space. The National Prevention Research Initiative has supported work to carry out research and development using this natural experiment to see if changes in built environment and planning can promote physical activity. The work, led by **Professor Frank Kee** (Queen's University Belfast), is already generating expertise that is being taken up in other park improvement projects. One example is a walkability model that encompasses the footpath network (as opposed to the road

centreline), another is a web-based system that helps incentivise individuals (in conjunction with the Physical Activity Loyalty Scheme).

A taxonomy for behavioural change

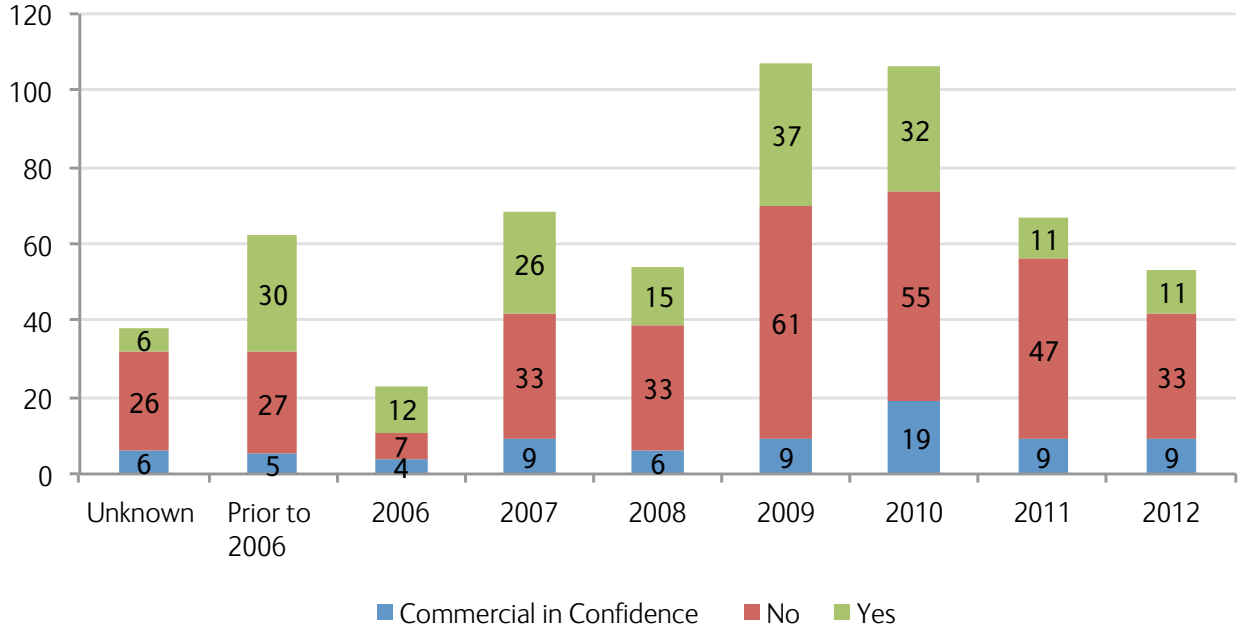
Professor Susan Michie (University College London) has highlighted that we lack a shared language for describing the content, especially the active ingredients, of behaviour change interventions (ie the techniques that lead to behaviour change). The Behaviour Change Techniques (BCT) Taxonomy v1.1, developed by Professor Michie and currently made available on an early release basis, provides a shared language for describing the content, especially the active ingredients, of behaviour change interventions. It will facilitate improved ability to replicate effective interventions, synthesise evidence and understand causal mechanisms underlying behaviour change.

Patents

Reports of patents were checked against a world patent database[13], and 489 of these records (85 per cent) were matched. 42 reports were matched to records of published applications in the UK patent office journal; the majority of these applications were either at an early stage of application, or had not been pursued further. The matching was greatly facilitated by researchers providing a publication reference for the patent.

It should be noted that the number of patents pursued to publication cannot be taken as an indication of the number of patentable discoveries arising from MRC-funded research. Many factors are taken into account in pursuing a patent, and given the costs of maintaining patent protection, the benefits to the host institution have to be carefully weighed up. The distribution of patent licensing by year of publication is shown in figure 3.

Figure 3: Numbers of patents licensed/not licensed/commercial in confidence, by year of publication



Case study

Factor IX for Haemophilia B, production of the first recombinant blood clotting factor

Haemophilia B is an X-linked bleeding disorder that results from a defect in the gene encoding coagulation factor IX (FIX), critical for blood clotting. It is less common than Haemophilia A, occurring in one in about 25,000 male births. The severity of Haemophilia B varies depending on the mutation inherited, but those patients with severe forms of the condition (about 60 per cent of patients) have serious spontaneous bleeding episodes and require regular preventative injections of Factor IX. Prior to 1999, this was prepared from human serum, with the associated risk of transmission of blood-borne viruses such as hepatitis and HIV.

In 1982, the gene for Factor IX was cloned by Kotku Kurachi and Earl Davie (University of Washington, Seattle) and the MRC-funded research group of George Brownlee (University of Oxford). The British Technology Group (BTG)[14] negotiated licenses to develop this discovery on behalf of both sets of inventors. In 1997, BTG secured an agreement for the Genetics Institute in Boston to produce a recombinant Factor IX product. By 1999, the work in the US had been successful and for the first time, an alternative to human serum, free of the risk of pathogens, was available to patients with Haemophilia B.

Wyeth distributed the product in the USA and two years later, Baxter Hyland Immuno took up distribution in the UK and Europe. In 2007, all distribution rights reverted to Wyeth (now Pfizer) and the clotting product was marketed as BeneFIX™.

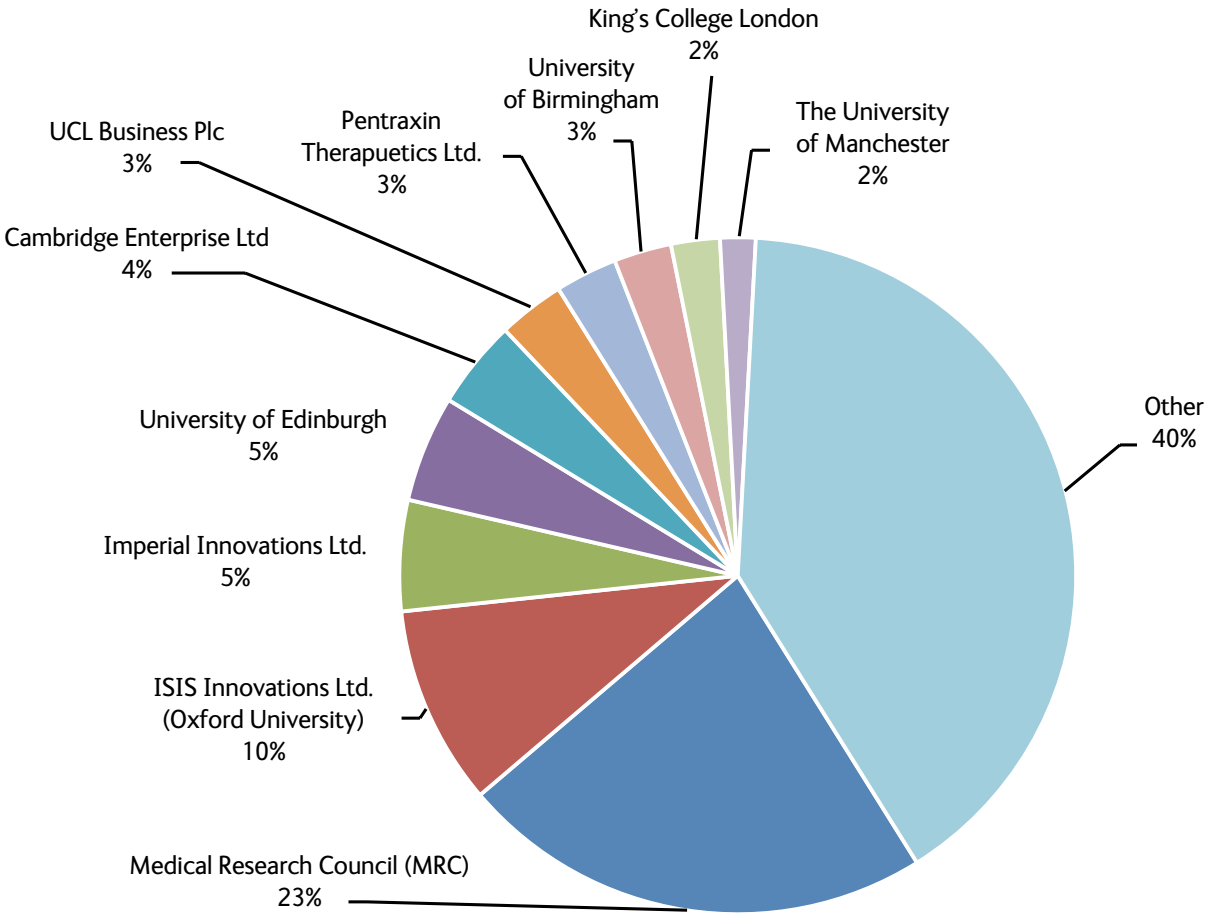
BTG's gross revenue from BeneFIX™ reached almost £180m over the ten years 2001 to 2011, with Pfizer's sales of the therapy reaching $775m in 2012 alone. 1,000 haemophilia patients in the UK, and in total, 13,000 patients worldwide regularly inject recombinant Factor IX. In 2011, the patents covering BeneFIX™ expired. BTG will cease to receive income from this license and Pfizer may face competition from other recombinant Factor IX products.

However, new approaches to therapy for this condition may not be far away from the market. In 2011, a group of MRC-funded researchers at University College London reported in the New England Journal of Medicine[15] unequivocal success in correcting Factor IX deficiency using a viral gene therapy approach[16]. Phase 2 trials of this gene therapy approach are underway, with the promise that functional levels of Factor IX may be able to be restored for patients without the life-long need for regular and costly injections.

Organisations as applicants on patents

We examined the details of the 489 reports matched to EPO records. These resolved into 431 unique patents. We can extract information for all named applicants on matched patents. The majority of patents have multiple applicants, and across all 431, there are almost 2,700 non-unique applicants listed. These include both organisations and researchers, with the organisations equalling 131 unique institutions. The frequency with which the 10 most highly cited organisations are listed as applicants is presented in figure 4.

Figure 4: Top 10 organisations as applicants on patents



Examples of private sector organisations that appear as applicants on patents arising from MRC-funded research are listed in table 1.

Table 1: List of private sector organisations appearing as applicants on patents arising from MRC-funded research

Private sector organisation	Summary	MRC-funded discovery/discoveries
ABLYNX NV	Belgian biotech company focused on the development of therapeutic "nanobodies" – heavy chain only antibodies.	**Professor Robin Weiss** (University College London) works on antibodies to HIV. He has used phage libraries derived from single-chain antibodies of llamas, known as "nanobodies". This work resulted in a joint patent. Although the patent has now been abandoned, collaboration with Ablynx continues.
ADPROTECH LTD	Now Inflazyme Pharmaceuticals Ltd, a biopharmaceutical company based in Canada focused on respiratory and inflammatory diseases.	Members of the MRC Centre for Transplantation at King's College London have licensed intellectual property to Adprotech Ltd. Between 1995 and 2000, Adprotech helped to fund some aspects of the kidney transplant research programme at King's College.
AGRES LTD	AgResearch is a New Zealand contract research institute focused on agricultural technology.	Researchers at the MRC/Southampton University Lifecourse Epidemiology Unit collaborate with AgResearch Ltd and the University of Auckland via "EpiGen" a consortium of the world's leading epigenetics research groups examining the early origins of chronic disease.
AUCKLAND UNISERVICES LTD	University of Auckland, New Zealand, technology transfer organisation.	
BIOMERIEUX, INC	In vitro diagnostics company.	**Professor Cheng-Hock Toh** (University of Liverpool) is developing approaches for monitoring hemostatic dysfunction, severe infection and systematic inflammatory response syndrome using blood samples.
BIOTIE THERAPIES CORP	A drug development company focused on neurodegenerative and psychiatric disorders, and inflammatory and fibrotic liver disease.	Researchers at the MRC/University of Birmingham Centre for Immune Regulation have patented a method of diagnosing fibrotic conditions on the basis of elevated level of soluble VAP-1 or SSAO activity in a bodily fluid, and a kit for use in this diagnostic method.
CAMBRIDGE ENTPR LTD	University of Cambridge technology transfer organisation.	Cambridge Enterprise is named on 20 patents in the MRC's dataset. The majority of these arise from work at the MRC/ Cambridge Centre for Stem Cell Biology and Regenerative Medicine.
CANCER REC TECH LTD	Cancer Research UK (CRUK) technology transfer organisation.	**Dr Nick Coleman** (MRC Cancer Cell Unit) is a co-applicant with Cancer Research Technology on a patent identifying biomarkers for cancer prognosis and screening of anti-cancer agents in recognition that this work was funded by both the MRC and CRUK.
CELLCENTRIC LTD	Drug development company focusing on epigenetics and cancer.	CellCentric has been working with **Professor Wolf Reik** (BBSRC Babraham Institute) since 2006. The company and Professor Reik's laboratory, which has been funded in part by the MRC, undertake on-going collaborative research looking at the mechanisms of epigenetic reprogramming. Patents from this work have been filed and licensed to the company.

Private sector organisation	Summary	MRC-funded discovery/discoveries
COMPTON DEVELOPMENTS LTD	The Compton Group has wide-ranging interests including the provision of research funding and venture capital, property investment and development, insurance and ceramics. It has been funding Bioscience research at the University of Cardiff since 1999.	**Dr Emma Blain** (Cardiff University) leads an MRC Developmental Pathway Funding Scheme (DPFS)-funded project looking at the efficacy of Frankincense as an anti-inflammatory treatment in osteoarthritis. The team have extracted the active compound and the relevant patent is held with Compton Developments.
EVOTEC AG	A drug discovery alliance and development partnership company based in Germany.	**Dr Christian Eggeling** (University of Oxford) is at the cutting edge of fluorescence microscopy and applies imaging techniques to study the immune system. Various methodological advances in high throughput analysis of samples have been commercialised via Evotec and other companies.
GE HEALTHCARE LTD	Global life sciences company.	GE Healthcare are named on four patents in the Researchfish dataset: **Dr Damian Tyler** (University of Oxford) is interested in studying the early stages of heart disease, and applies cutting-edge MR spectroscopy visualisation techniques to monitor pyruvate metabolism in healthy and diseased tissue. **Professor Chris Morris** (University of Newcastle) is applicant on two patents concerned with glutamate markers for late-onset depression. **Dr Anne O'Garra** (MRC National Institute of Medical Research - NIMR) is applicant on a patent for a blood transcriptional signature for tuberculosis infection.
GENENTECH INC	Global biotechnology company.	**Dr Avrind Patel** at the MRC/Glasgow Centre for Virus Research and the MRC Technology Centre for Therapuetics Discovery patented an antibody with the potential to treat Hepatitis C virus infection.
HEPTARES THERAPEUTICS LTD	MRC spin out company focusing on GPCRs as therapeutic targets.	Several MRC patents in the Researchfish dataset have been assigned to Heptares Therapeutics. (See chapter 10 – Impacts on the private sector).
IMMUNOBIOLOGY LTD	ImmBio Ltd is a Cambridge-based vaccine development company, developing the next generation of anti-infective vaccines.	**Dr Andrew Gorringe** (Health Protection Agency) is named on a patent for a potential vaccine for meningococcal disease. The HPA has developed a GMP-ready manufacturing process and built on TSB-funded collaborative with ImmBio Ltd, and Bristol University. Further development of the vaccine is now supported by MRC DPFS funding. The product is currently undergoing preclinical testing.

Private sector organisation	Summary	MRC-funded discovery/discoveries
IMP INNOVATIONS LTD	Imperial College technology transfer organisation.	Imperial Innovations is listed on 25 patents in the Researchfish dataset, often jointly with other university technology transfer organisations, emphasising the collaborative nature of medical research. Examples include: **Dr Rudiger Woscholski** (Imperial College) has discovered a novel high affinity small molecule inhibitor specific for the tumour suppressor PTEN; this discovery has been patented and licensed. **Professor Robin Leatherbarrow** (Imperial College) and collaborators (including **Dr Anthony Holder** at MRC NIMR) have identified compounds that strongly inhibit the enzyme N-myristoyltransferase. This enzyme has been validated pre-clinically as a target for the treatment of fungal and trypanosome infections. The work included collaboration with Pfizer and has the potential to provide new therapies for neglected tropical diseases[17]. **Professor David Klenerman** (University of Cambridge), in collaboration with the EPSRC-funded group of Professor Korchev at Imperial College, has developed a method based on a scanning nanopipette that allows robust, high resolution, non-contact imaging of living cells, down to the level of individual protein complexes. It can also be used to probe function by performing nanoscale assays, such as locally deliver controlled amounts of reagents or performing single ion channel recording. Professor Klenerman is using this to watch the details of biological process taking place on the surface of living cells, including viral entry and probe the structure of the cell membrane. Intellectual property based on **Professor Tracy Hussell's** (University of Manchester) research has been licensed to StormBio Inc (Imperial College). (See chapter 10 – Impacts on the private sector). **Professor Steve Bloom** (Imperial College) reported patents covering novel analogues of the gut hormone peptide YY. This molecule is being developed for a phase 1 clinical trial with support from an MRC development clinical study award[18].
IO THERAPEUTICS INC	Io Therapeutics Inc. is a privately held company headquartered in California, focused on the development of novel treatments for cancers, neurodegenerative diseases, and autoimmune diseases.	**Professor Randolph Noelle** (King's College London) and colleagues have protected the use of selective retinoic acid receptor alpha (RARA) agonists for the treatment of inflammation and autoimmune diseases as part of a wider translational immunotherapy research programme.

Private sector organisation	Summary	MRC-funded discovery/discoveries
ISIS INNOVATION	University of Oxford technology transfer organisation.	ISIS innovation is listed on 10% of patents in the Researchfish dataset. Examples include: **Professor George Brownlee** (University of Oxford) and colleagues have developed a quantitative method for detecting accessibility of proteins to chemical modification using mass spectrometry[19]. The method may be useful in the rational design of drugs. **Professor Anant Parekh** (University of Oxford) has identified novel biological pathways involved in allergic rhinitis and polyposis. These are inflammatory responses within the nasal cavity suffered at some time by an estimated 20% of the population. A key player in the development of allergic diseases like asthma is the immune system mast cell. Professor Parekh's work has involved filing patents on novel aspects of mast cell biology, and led to funding from GlaxoSmithKline to develop new drugs that specifically control mast cell secretion. Intellectual property that forms the foundation for ReOx Ltd is based on the work of **Professors Peter Radcliffe, Patrick Maxwell** and **Chris Pugh**. (See chapter 10 – Impacts on the private sector).
ITI SCOTLAND LTD	ITI Scotland is a publicly-funded organisation, set up by Scottish Enterprise, that supports sustainable economic growth in Scotland through market-driven R&D programmes.	**Miles Houslay** is currently Professor of Pharmacological Innovation at King's College, London. While previously at the University of Glasgow, he and colleagues discovered novel ways modifying the differentiation of human stem cells in culture that are actively being exploited in research and development.
IXICO LTD	An imaging contract research organisation based in London and Chicago, established by Imperial College.	**Professor Jo Hajnal's** research at the MRC Clinical Sciences Centre has led to significant improvements in magnetic resonance imaging in medicine, particularly in aspects of data acquisition and processing, image registration and data fusion as well as novel scanner technology, parallel imaging and motion artefact correction. Professor Hajnal helped establish Ixico Ltd which aims to provide services for clinical trial imaging that reduce cost and improve quality. Professor Hajnal has recently moved to King's College London.

Private sector organisation	Summary	MRC-funded discovery/discoveries
KCL ENTPR S LTD	King's College London technology transfer organisation.	King's College London is applicant on 11 patents in the Researchfish dataset. Examples include: **Professor Swee Lay Thein** (King's College) has identified genetic variants that could be used to predict an individual's ability to produce foetal haemoglobin, of potential impact in genetic counselling and prenatal diagnosis. Both the University of Cambridge for Brain Repair and the King's College London Wolfson Centre for Age-Related Diseases have been key to the discovery that Chondroitinase promotes plasticity and recovery after spinal cord injury, and to preparations to take these findings into clinical studies. **Professor Alistair Compston** (University of Cambridge) reported patent JP2010132682[20] held jointly by the University of Cambridge and King's College London. **Professor Simon Lovestone's** research on Alzheimer's disease has led to a patent on the use of Glycogen Synthase Kinase 3 (GSK-3) as a biomarker for the disease. Subsequent research has shown that GSK-3 has potential as a therapeutic target and clinical studies are underway.
KONINKL PHILIPS ELECTRONICS NV	A global electronics company, headquartered in Amsterdam.	Another aspect of **Professor Miles Houslay's** research, concerned with expression profiling for diagnosis of prostate cancer, has been developed with input from Philips.
MEDICAL RES COUNCIL TECHNOLOGY	The MRC's technology transfer organisation.	MRC and/or MRC Technology are listed as applicants on 23 per cent of patents in the Researchfish dataset. Examples include: Intellectual property licensed to Anaptys Bio Inc. based on **Dr Michael Neuberger's** work at the MRC Laboratory of Molecular Biology. (See chapter 10 – Impacts on the private sector). Assays for many specific kinases, important for research and therapeutic development across a wide range of diseases have been developed at the MRC Protein Phosphorylation Unit, University of Dundee. For example, the WNK (With No lysine Kinase) kinases have been implicated as a potential target to treat hypertension. Mutations in the human genes encoding WNK1 and the related protein kinase WNK4, are the cause of Gordon's hypertension syndrome. This specific patent[21] discloses the naturally occurring substrates for WNK1 and 4 and describes an assay to identify modulators of their activity. The MRC is listed as applicant on patents concerning an innovative new test – the cytosponge[22] - which is essentially a sponge on a string- to diagnose the precursor of oesophageal cancer, catching it early and saving lives. A large multi-centre clinical trial is now underway to investigate the findings. The cytosponge is the invention of **Dr Rebecca Fitzgerald** (MRC Cancer Cell Unit).
MITSUI NORIN KK [JP]	The Mitsui Norin company is a manufacturer of green tea extracts.	**Professor Peter Taylor** (University College London) has identified combinations of naturally occurring catechins that sensitise the pathogenic bacterium Staphylococus aureus to antibiotics.

Private sector organisation	Summary	MRC-funded discovery/discoveries
NAT INST FOR BIOPROC RES AND TRAINING LTD [IE]	The National Institute for Bioprocessing Research and Training (NIBRT) is a centre of excellence for training and research in bioprocessing. NIBRT is located in Dublin, Ireland.	The MRC Human Genetics Unit (HGU) has had a long-term interest in discovering significant associations between genetic factors and major diseases such as diabetes and cancer. Intellectual property has been generated as a result of large international collaborative studies, led by researchers at the MRC HGU, involving partners at Genos and NIBRT. The work has identified genetic polymorphisms that affect protein glycosylation, and glycosylation markers that are important in maturity onset diabetes of the young (MODY).
GENOS Ltd	Genos Ltd is a contract research organisation located in Zagreb, Croatia, which provides service for numerous universities, hospitals and private individuals in Europe and overseas. Expertise at Genos is in the fields of molecular genetics and glycomics.	
NEUROTARGETS LTD	University of Bristol spin out with a focus on neuropathic pain.	**Professor David Wynick** (University of Bristol) was granted patents in Europe corresponding to his discovery that a galanin agonist might have potential as a treatment for disorders of cognition and Alzheimer's disease. Earlier work on galanin was funded in part by the MRC via a Career Establishment Grant and an MRC Clinical Senior Fellowship. Professor Wynick has subsequently been awarded a second phase Wellcome Trust seeding drug discovery initiative award of £3.8 million, and is working closely with the University of Bristol spin out company Neurotargets Ltd to bring a new analgesic drug to market.
NIPPON TELEGRAPH & TELEPHONE	NTT is a Japanese telecommunications company.	NTT is a co-applicant on several patents arising from the London Nanotechnology Centre funded by the MRC and EPSRC. The patents concern protein chips and microscopy.
NOVATHERA LTD	UK regenerative medicine company, now merged with MedCell Bioscience Ltd.	See chapter 10 – Impacts on the private sector.
NUTRICIA NV	Nutricia is a specialised nutrition company, now part of the French company Danone.	**Professor Jimmy Bell's** (MRC Clinical Sciences Centre) research programme focuses on the interaction between genes, internal homeostatic mechanisms and the environment in obesity and insulin resistance. This research has identified human milk fortifiers comprising high protein content and long chain poly-unsaturated fatty acids. Use of such human milk fortifier improves the body adipose tissue distribution by increasing the subcutaneous adipose tissue mass, while at the same time not increasing visceral adipose tissue.
OMEROS CORP	US-based company focusing on drugs to improve surgical outcomes.	**Professor Wilhelm Schwaeble** (University of Leicester) discovered a new component of the complement system (MASP-2) which recognises carbohydrate structures present on microbial organisms. The patent, in which the Omeros Corporation is co-applicant, covers technology used to inhibit this activation pathway of complement and its application in treating ischaemic pathologies including organ transplantation.

Private sector organisation	Summary	MRC-funded discovery/discoveries
PENTRAXIN THERAPEUTICS LTD	UCL spin out company.	Pentraxin Therapeutics is listed on 18 reported patents. (See chapter 10 – Impacts on the private sector).
PHAGENESIS LIMITED	University of Manchester spin out company	Phagenesis is listed on two patents. (See chapter 10 – Impacts on the private sector).
PHARMACIA DIAGNOSTICS AB [SE]	Now part of Thermo Scientific, Pharmacia was originally based in Uppsala, Sweden and largely focussed on immunodiagnostics.	**Dr Annalisa Pastore** (MRC NIMR) is interested in the relationship between the structure and function of proteins. The patent in which Pharmacia is co-applicant covers the design of a non-anaphylactic form of the grass pollen Ph1 p6 allergen and its use in drug development.
PROTEOME SCIENCES PLC	An applied proteomics company delivering content for personalized medicine in the areas of biomarker services, assays and reagents.	**Dr Diane Hanger** (King's College London) reported a collaboration with Proteome Sciences plc prior to 2006 which identified new Tau phosphorylation sites, via mass spectrometry, from material extracted from human brain[23]. The resulting patent discloses methods for screening for substances capable of modulating the phosphorylation of tau protein, which may be therapeutically useful in the treatment of neurodegenerative diseases. (See chapter 10 – Impacts on the private sector for further interactions with Proteome Sciences).
PROCURE THERAPEUTICS LTD [GB]	York University spin out company.	See chapter 10 – Impacts on the private sector.
REGEN THERAPEUTICS PLC	A UK company focusing on the commercialisation of Colostrinin™ as a nutraceutical product, the development of Colostrinin™ peptides as pharmaceutical drug candidates and the development of a new use for an existing drug (zolpidem).	**Dr Ian Stanford** and colleagues at Aston University hold a patent describing the potential for low, sub-sedative doses of the hypnotic drug zolpidem to be used as a cognitive enhancer in patients with brain injury (and neurodegenerative disease).
RTS LIFE SCIENCE LTD	A supplier of automated systems for biobanking and management of compounds and samples.	Work to establish the UK Biobank has broken entirely new ground with respect to the large scale collection, processing and storage of biological samples. One patent arising from the automated processing of blood samples is held jointly with RTS Life Science Ltd and a further patent is held with TAP covering the use of -80oC storage.
THE AUTOMATION PARTNERSHIP	TAP provides automation systems and consumables to improve productivity in life science research	
SYNGENIX LTD	Cambridge-based company engaged in the development and delivery of targeted medications for diseases of the nervous system.	**Professor Andrew Lever** (University of Cambridge) reported a patent describing novel lentiviral vectors, which is held jointly with Syngenix, and was granted prior to 2006. Professor Lever reports that a following successful application of this technology in phase 1 clinical trials in 2012, the university and inventors have received royalty income.

Private sector organisation	Summary	MRC-funded discovery/discoveries
TOLERX INC [US]	A US-based pharmaceutical company focused on discovering and developing new therapies designed to treat patients by reprogramming the immune system, allowing for long-term remission of immune-related diseases after a short course of therapy.	Tolerx was formed in part to develop and commercialise a monoclonal antibody for type 1 diabetes (otelixizumab). Its co-founder is **Professor Herman Waldmann** (inventor of the Campath series of antibodies) and an agreement to co-develop otelixizumab with GlaxoSmithKline generated around $70 million in upfront cash. However otelixizumab failed to hit the primary efficacy endpoint in phase 3 trials[24] and Tolerx Inc. was closed at the end of 2011. Tolerx had spent about a decade doing research and development on drugs for immune-related disorders. GSK has taken over development of otelixizumab.
UCL BUSINESS PLC	University College London technology transfer organisation.	UCL Business is co-applicant on 15 patents arising in part from MRC-funded research. Examples include: **Professor Mala Maini** (MRC Centre for Molecular Virology, University College London) has proposed a method of treating liver damage, especially hepatitis B virus (HBV) related liver damage using agents to block TNF- related apoptosis-inducing ligands (TRAIL). **Professor Hugh Gurling** (University College London) and colleagues have constructed a genetically engineered mouse strain (NK1R-/-). The behavioural abnormalities expressed by the NK1R-/- ('knockout') mouse resemble those seen in humans with Attention Deficit Hyperactive Disorder (ADHD) and include hyperactivity with deficits in cognitive performance. Neurochemical abnormalities in the brain are also consistent with our understanding of the brain mechanisms underlying this disorder and the mechanism of action of drugs used to treat ADHD. This mouse strain has already been used to generate new potentially useful drug candidates for this condition.
UMC UTRECHT HOLDING BV	Technology transfer organisation for Utrecht University (UU) and University Medical Centre Utrecht (UMC Utrecht).	**Professor Richard Farndale** (University of Cambridge) reported a patent granted covering the Von Willebrand Factor (VWF) binding site in collagen III prior to 2006. However, this discovery was not licensed for several years, and as the costs of maintaining patents are significant, the patent was allowed to lapse. Professor Farndale reports however that two companies have recently purchased peptides from the group to develop assays for VWF in plasma, an essential part of the diagnosis of non-haemophiliac bleeding disorders. This may lead to new diagnostic tests being developed based on MRC-funded research.

Endnotes

1. A study of over 1200 patents published by the University of California and the University of Columbia in all disciplines between 1980 and 1994 found that 41 per cent of these were licensed by 1992. A similar study of 686 patents published by the Memorial Sloan-Kettering Cancer Centre and Dana Faber Cancer Institute between 1983 and 2003, also found that 41 per cent of these were licensed by 2007. Other studies have indicated a lower proportion of patents licensed (for example, 25 per cent of NASA patents published between 1994 and 2002 were licensed by 2007).
2. The worldwide patent search offered by the European Patent Office (EPO), Espacenet was used http://www.epo.org/searching/free/espacenet.html?hp=stages
3. Prior to the UK Government granting the rights generated from government-funded academic research to universities in 1987, most commercialisation of such intellectual property was carried out by the British Technology Group (BTG), subsequently privatised as BTG plc. It was BTG and its predecessor organisations that considered commercialisation of MRC discoveries in the 1970s and early 1980s such as monoclonal antibodies and magnetic resonance imaging. Post-1987, the MRC established MRC Technology as an independent technology transfer organisation to manage intellectual property arising from the MRC's intramural research programme.
4. Adenovirus-Associated Virus Vector–Mediated Gene Transfer in Hemophilia B http://www.nejm.org/doi/full/10.1056/NEJMoa1108046
5. Haemophilia gene therapy shows early success http://www.bbc.co.uk/news/health-16107411
6. Selective Inhibitors of Protozoan Protein N-myristoyltransferases as Starting Points for Tropical Disease Medicinal Chemistry Programs PLoS Negl Trop Dis 6(4): e1625. (2012) doi:10.1371/journal.pntd.0001625 http://www.plosntds.org/article/info%3Adoi%2F10.1371%2Fjournal.pntd.0001625
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8. A quantitative strategy to detect changes in accessibility of protein regions to chemical modification on heterodimerization Protein Sci. 2009 Jul;18(7):1448-58 http://www.ncbi.nlm.nih.gov/pubmed/19517532
9. JP2010132682 "Treatment of Central Nervous System Damage" (2010)
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12. Novel phosphorylation sites in tau from Alzheimer brain support a role for casein kinase 1 in disease pathogenesis. J Biol Chem. 2007 Aug 10;282(32):23645-54 http://www.ncbi.nlm.nih.gov/pubmed/17562708
13. Tolerx, Inc. and GlaxoSmithKline (GSK) Announce Phase 3 Defend-1 Study of Otelixizumab in Type 1 Diabetes Did Not Meet Its Primary Endpoint http://www.biospace.com/news_story.aspx?StoryID=213614&full=1

researchfish

MRC Medical Research Council

Outputs, outcomes and impact of MRC research: 2012 report

09: Development of products or interventions

Development of products or interventions

Summary

In this chapter, researchers were asked to report on products and interventions that had been developed to a new stage since 2006. Products and interventions were defined as drugs and vaccines, diagnostic tests, biomarkers and diagnostic imaging techniques, medical devices, surgical interventions and public health interventions. Recipients of 10 per cent of all awards reported on work that had generated a product or intervention. In total, 686 reports of products and interventions were recorded. This is an increase on last year's data, which recorded 508 reports (nine per cent of all awards resulted in the generation of a product or intervention).

Last year, information on the devolved portfolio awards made under the Developmental Pathway Funding Scheme (DPFS) was collected for the first time. DPFS devolved portfolios are major awards made to a small number of universities. These universities then manage their own portfolio of DPFS awards.

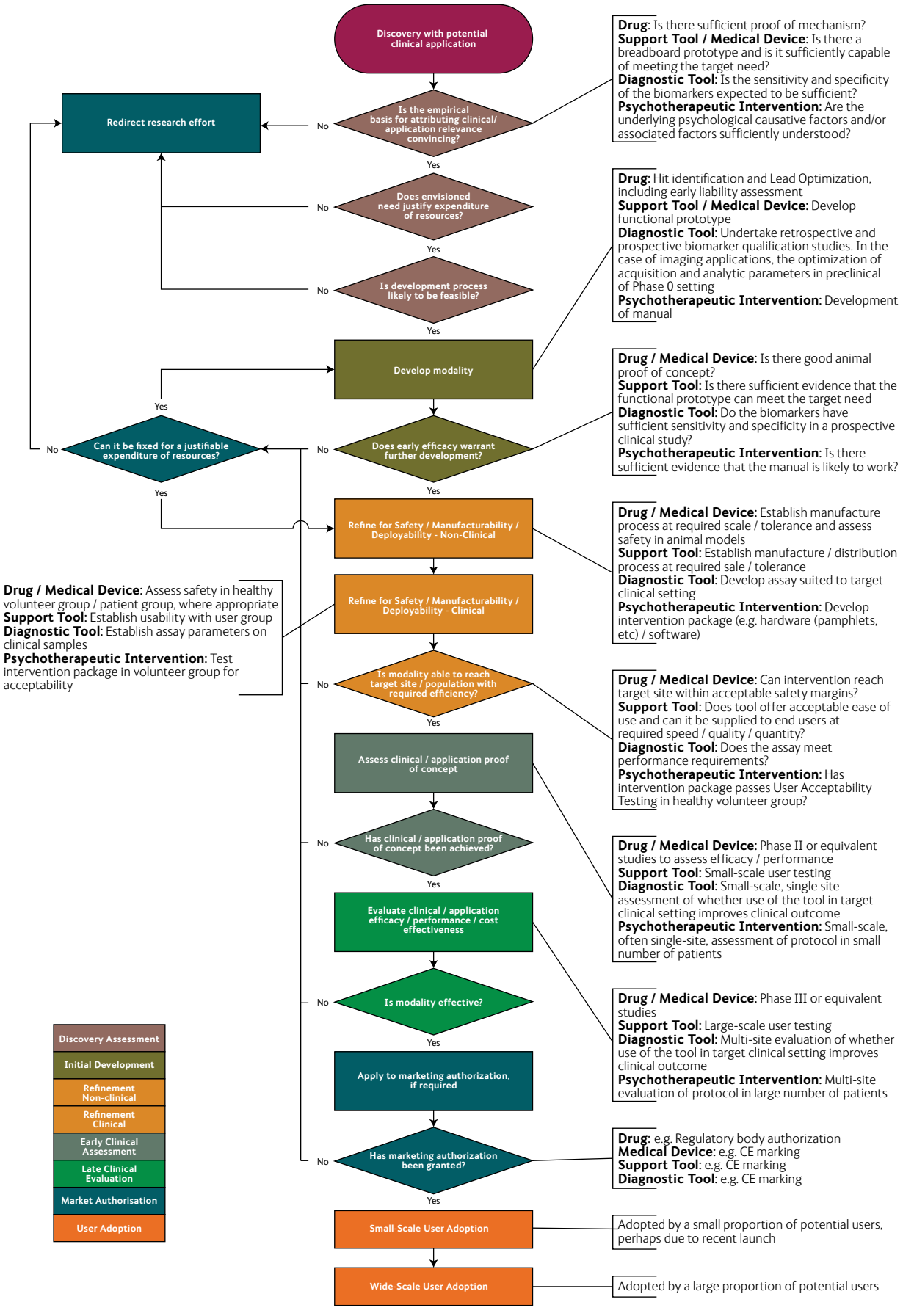
The data will also include a number of reports which cover impacts realised through changes to policy or practice, and these may be migrated to chapter 6 (Influences on policy). Also included were a number of reports that covered the discovery of new research methods and tools, such as reagents. Some of these may be better considered under chapter 7 (Research materials), however some may be reagents that are sold as a product or service and should properly be considered in this section. As further analysis is carried out, researchers may be asked to amend their entries next time they edit their Researchfish data. We expect that this information will need to be regularly revised as products progress through development.

Some of the outputs reported are at a very early stage, and we need to consider whether these had actually yet embarked on a process of product development. The section also includes a question to ascertain whether the product was still under active development. A flowchart for assigning a developmental stage to a product or intervention is shown at figure 1.

Data are summarised with respect to the status of development work (whether projects are active, on hold or closed), the year that the latest developmental stage was reached, the stage of development (whether products are in 'initial development' all the way through to 'wide scale adoption') and the type of product or intervention described.

A selected list of products is included; in some cases these examples have previously been reported, however updated details have been added.

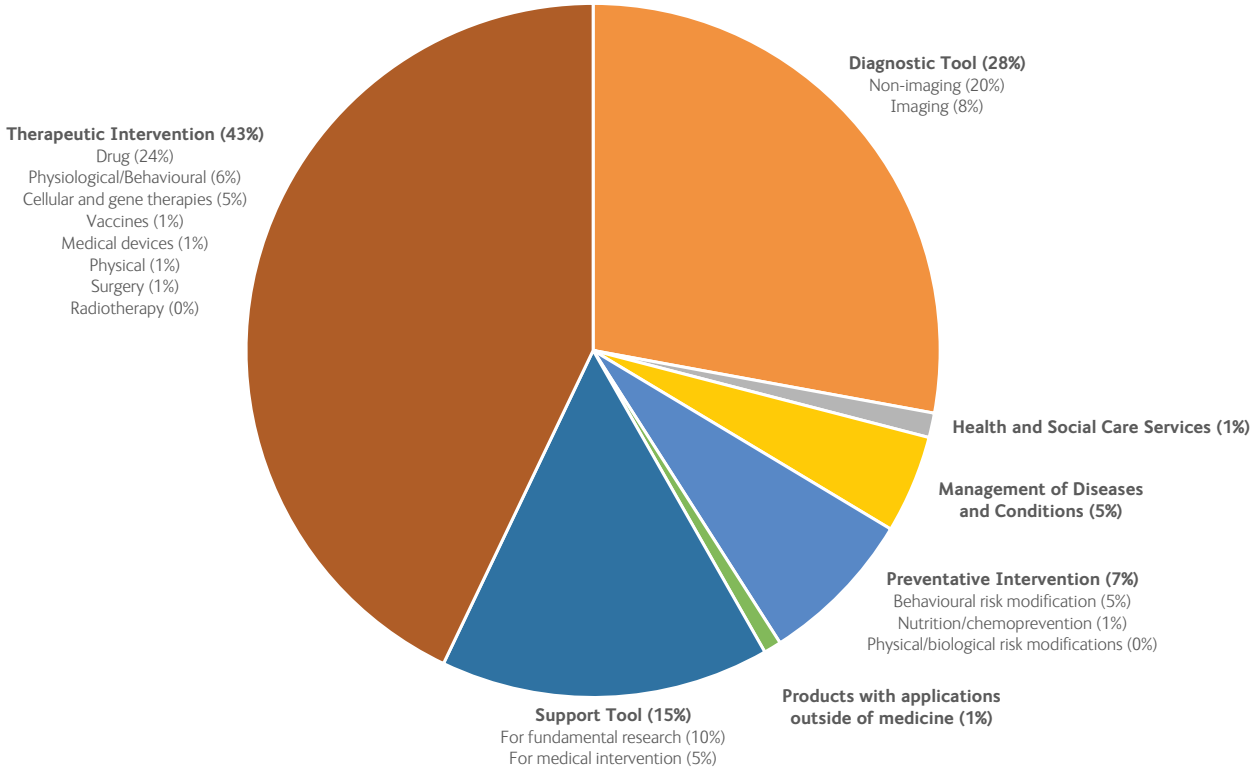
Figure 1: Flowchart for assigning a developmental stage to a product or intervention



Products and interventions by type

The most common type of product or intervention in development was the therapeutic intervention – drug, reported by 146 awards (24 per cent of all products and interventions reported). This was closely followed by the diagnostic tool – non-imaging, reported by 124 awards (20 per cent of all products and interventions). The percentage of products and interventions by type is shown in figure 2.

Figure 2: Products and interventions by type



Products and interventions by development stage

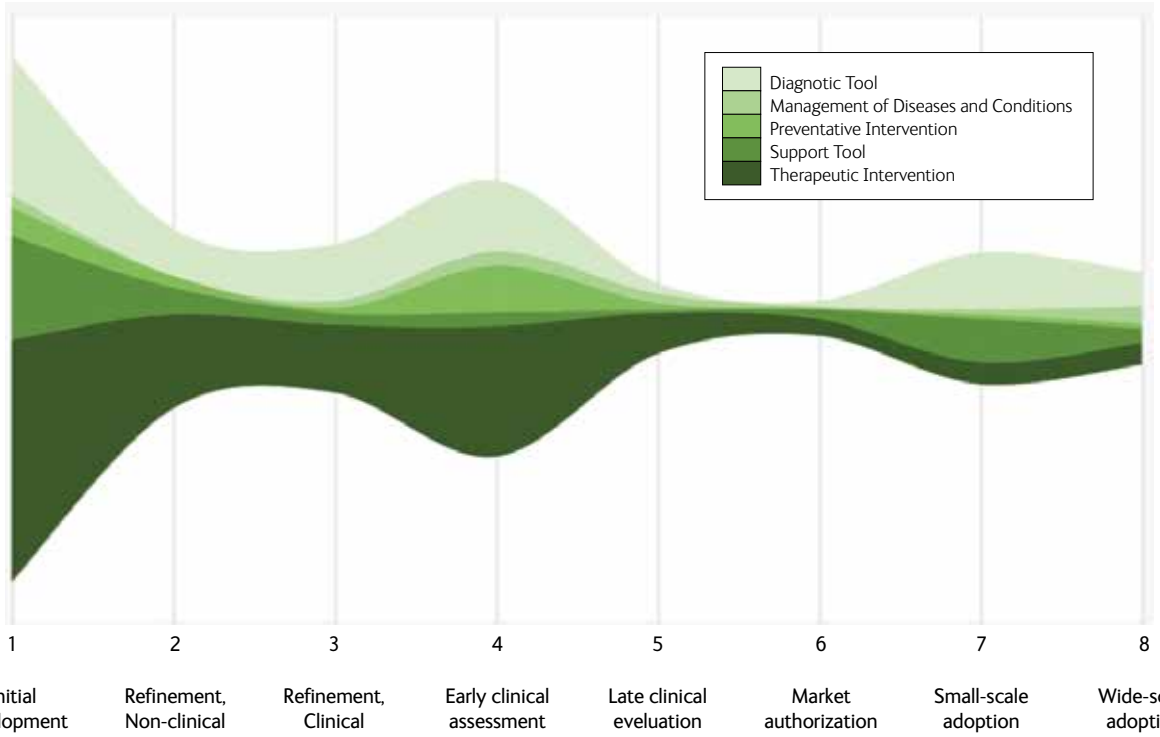
A total of 96 awards reported products and interventions as being launched onto the market since 2006, with a further 14 awards reporting products and interventions currently undergoing the process of market authorisation.

There were 145 reports of products and interventions in early- or late-stage clinical evaluation and 358 reports of products in initial or refinement stages. The inclusion of DPFS projects in 2011 has significantly added to the number of projects in early developmental stages.

Figures 3 and 4 show the distribution of products and interventions by development stage.

In 2012, interest was raised in the number of 'investable opportunities' being produced by MRC-funded research groups. The Researchfish data show that there are a significant number of such products and interventions at all stages of development, spanning both translational gaps identified in the 2006 Cooksey review of health research[1]. Particular interest was raised concerning developments that faced the 'valley of death'[2], sometimes referring to the attrition rate of projects between initial development and early clinical studies, but more commonly referring to the difficulty in obtaining commercial partners to take products into late-stage clinical evaluation and beyond. Assistance to translate discoveries such as these, is available under the Biomedical Catalyst Fund[3] which aligns existing MRC translational research schemes with new funding for the Technology Strategy Board. The Biomedical Catalyst Fund will support £180m of work within this spending review period.

Figure 3: Products and interventions by development stage



As expected, this graph shows a large proportion of products and interventions at the initial development stage. However, interestingly, it also shows that the MRC pipeline includes a relatively large number of products in early clinical assessment. This is largely due to the MRC's increased investment in this area via initiatives in experimental medicine and the DPFS.

Figure 4: Number of products and interventions by development stage

	Therapeutic Intervention	Diagnostic Tool	Support Tool	Preventative Intervention	Management of Diseases and Conditions
Initial development	100	57	43	12	5
Refinement. Non-clinical	39	19	11	5	0
Refinement. Clinical	28	23	5	2	3
Early clinical assessment	54	29	6	19	6
Late clinical evaluation	17	4	1	3	4
Market authorisation	7	2	4	0	1
Small-scale adoption	9	23	18	2	2
Wide-scale adoption	9	14	6	2	7

Year reported for the current stage of development

Researchers reported the year in which the product or intervention under development had reached its current stage. Over time, this information will allow us to ascertain the rate at which development progresses from one stage to the next, by comparing differences between our annual datasets. It will also allow us to follow up reports of products which have not progressed for some years to validate whether work is still underway and what the barriers are to progress. Included at the end of this section are examples of where there is recent, specific evidence of translation.

Case studies

Humanised Antibody Technology, an MRC discovery which has revolutionised medicine

MRC research provided key discoveries that established monoclonal antibodies as a new therapeutic intervention. The pipeline of therapeutic antibody drugs is now the fastest growing in the pharmaceutical industry, with a $40 billion global market in 2009/10, projected to reach $60bn by 2014[4].

MRC research has played a key role in the development of 10 per cent of monoclonal antibody drugs currently approved for use. The first therapy to reach blockbuster status was Humira® with $1bn in sales in 2005. By August 2009, Humira was being used in 80 countries in the treatment of 370,000 patients, and it is now estimated to be the world's top earning pharmaceutical product, with sales predicted to reach $10bn by 2016[5].

In particular, antibody drugs have revolutionised the treatment of inflammatory conditions such as rheumatoid arthritis (RA). RA is a disease of the joints, which can result in eventual destruction of the joint interior and the

surrounding bone, leading to disability. RA is a serious unmet clinical need (it is estimated that 1 per cent of the world's population suffer from RA[6], approximately 400,000 people in the UK, and that the cost to the UK economy is between £3.8 and £4.75bn per year[7]). The discovery of the role of TNF in RA by Feldman and Maini at Imperial College[8] and subsequent use of monoclonal antibody therapies to inhibit TNF, has transformed RA treatment with more than two million patients worldwide receiving anti-TNF antibody treatment.

Information provided via Researchfish is tracking the progress and impact of six antibodies which owe their development to MRC research (including Humira®) approved for use in eight conditions between 2006 and 2009, and others that are at earlier stages of development. A detailed summary of these was presented in the 2010 e-Val report[9].

In 2010 we reported that BenLysta® had received regulatory approval in the US and Europe. BenLysta was developed by Human Genome Sciences and GSK using MRC phage display technology. In 2012 NICE issued draft guidance that did not recommend the antibody for treatment of systemic lupus erythematosus (SLE) in the NHS. In 2013 NICE launched a public consultation on this draft guidance[10].

There has recently been little change in the regulatory status of other antibody therapies on the market. A notable exception was NICE issuing draft guidance[11] for use of RoActemra (Tocilizumab) for treating systemic juvenile idiopathic arthritis (JIA) in October 2011. The guidance was for treatment of children aged two years and older, where specific previous treatments have not produced an adequate response, and was dependent on being made available by the manufacturer under a discount agreed as part of the patient access scheme. In addition, despite promising clinical trial results[12], there were delays in bringing Briakinumab to market as Abbott withdrew applications for a licence for the drug in the US and Europe in January 2011.

We also became aware that both the FDA and EMEA had issued licences to market eculizumab (Soliris™), a monoclonal anti-C5 antibody, for the treatment of atypical haemolytic uremic syndrome (aHUS). aHUS is an ultra-rare, life-threatening, genetic disease that progressively damages vital organs. Professor Tim Goodship's MRC funded group in Newcastle participated in a multicentre study crucial to these regulatory decisions.

At an earlier stage of development, Phase II trials Tralokinumab were completed in 2011 of (previously known as CAT-354, AstraZeneca). This antibody targets interleukin 13, a T-lymphocyte-derived cytokine that plays a key role in the development and maintenance of the human asthmatic phenotype. CAT-354 was Cambridge Antibody Technology's first antibody to be discovered using ribosome display[13] and is being developed by MedImmune.

In 2012, Tralokinumab received orphan drug designation for Ideopathic Pulmonary Fibrosis (IPF) by the FDA. Orphan drug designation is awarded to drugs intended to treat rare conditions that companies otherwise might not be able to develop for financial reasons. IPF is a chronic, progressive, irreversible, and usually fatal lung disease of unknown cause. A phase 2a study to evaluate the safety and effectiveness of multiple doses of tralokinumab on pulmonary function in adults with mild to moderate idiopathic pulmonary fibrosis (IPF) is underway.

Development of the Cytosponge - a non-endoscopic immunocytological device for Barrett's oesophagus (BE) screening

Barrett's oesophagus is an alteration of the oesophageal tissue and can occur in people who have had heartburn over a considerable period of time. It is the main risk factor for oesophageal cancer. In the UK, at least 375,000 people are estimated to develop Barrett's oesophagus each year, and this appears to be rising. Ten per cent of these patients will then go on to develop oesophageal cancer. Unfortunately, once cancer is diagnosed, there is only a one in ten chance of survival after five years.

Researchers from the MRC Cancer Cell Unit, Cambridge, are developing a new approach to diagnosing Barrett's oesophagus, using a kit called the 'Cytosponge'. By catching this pre-cancerous condition early it may be possible to prevent a type of cancer of the oesophagus, the sixth most common cause of death from cancer in the UK.

The team, led by Dr Rebecca Fitzgerald[3], completed early clinical assessment of the technique in 2010. The findings published in the BMJ showed the Cytosponge provided an accurate and less uncomfortable method of diagnosis.

The approach involves patients swallowing a capsule with a string attached and taking a drink of water. The device then dissolves in the stomach to expand into a sponge-like mesh 3cm wide. Five minutes later, the expanded Cytosponge is removed through the mouth by pulling on the string, collecting cells for analysis en route. These cells are then tested for a molecular marker (also developed by the MRC research team), which allows identification of Barrett's cells, if present, under the microscope.

The work has produced over 40 research papers and attracted just under £1m of non-MRC funding since 2006 in addition to MRC core and supplemental funding of £3.5m between 2006/07 and 2011/12. Wider academic and industry collaborations have been established which have led to a new hypothesis for the development of BE and suggested potential therapeutic approaches to be tested in future.

CRUK have now provided funding for further clinical assessment of the Cytosponge approach in a larger trial, and the National Health and Medical Research Council of Australia has similarly funded a phase 2 study recruiting in Melbourne.

New analysis led by the MRC Biostatistics Unit in 2012 showed that screening by the Cytosponge followed by treatment of patients with dysplasia or intra-mucosal cancer would reduce the number of cases of incident symptomatic oesophageal adenocarcinoma by 19 per cent, compared with 17 per cent for screening by endoscopy[4].

Magnetic Resonance Imaging - a new technology that has revolutionised medicine

1974 - 1980 MRI invented, research financed by the MRC.

1983 Oxford Instruments (Oxford University's first spin out in 1959) provides first superconducting magnets for MRI.

British Technology Group licenses intellectual property from Oxford, Nottingham and Aberdeen universities having built a strong patent portfolio.

First MRI machine available in 1983, in clinical use in 1985.

1989 Between 1986 and 1989 99 per cent of the world's MRI manufacturers were licensed, including GE, Marconi, Siemens, Toshiba, Hitachi and Shimadzu, Bruker, Fonar and Esaote.

2003 **20,000 MRI machines used world-wide, 60 million scans performed every year.**

Estimated £200m returned to universities under royalty arrangements first with Johnson and Johnson, GE and then others.

US company GE buys Amersham Life Sciences for £5.7bn, increasing its base in the UK and securing medical diagnostic capabilities.

Nobel Prize awarded to Professor Peter Mansfield.

2010 **Global MRI sales $4.5bn**

MRI associated industries estimated to add around **£600m to UK GDP** between 2011 and 2015[16].

GE Healthcare has 30 per cent of Global MRI market. GE UK sales across all sectors is £5bn (19,000 employees – **1000 of which are at Amersham in medical diagnostics**).

Oxford Instruments is a leading supplier of parts/servicing for MRI machines (has 1900 staff worldwide and joined the FTSE 250 in 2011; the company spends £29m on R&D and has a turnover of £330m).

Increased success in spinal surgery resulting from MRI is estimated to **save the UK £166m each year in terms of working days**.

Improved limb salvage surgery estimated to save the NHS £5-10m per year.

Significant improvements in cancer therapy, for example, breast and cervical cancer, result from the use of MRI.

Selected examples of new products and interventions

Use of Smartphone applications

With the dramatic rise in use of smartphones[14] there has been an increase in the use of this technology in research, in healthcare and as a route to deliver information to wider audiences including the public. The implementation of such products can be extremely rapid, and MRC-supported research groups have launched a number of applications for use by healthcare professionals and the public over the last two years. It will be of interest to examine the longer-term impacts of the use of these.

Antibiotic prescribing

The national Centre for Infection Prevention and Management (CIPM) is a UK Clinical Research Collaboration (UKCRC) funded project, and a collaboration between Imperial College London, Imperial College Healthcare and the Health Protection Agency. By leveraging the expertise of molecular microbiologists, epidemiologists, statisticians, clinicians, pharmacists, infection control practitioners and health management researchers, the venture is a truly multi-disciplinary approach to infection prevention and management.

A smartphone application was developed to help staff treat infections across Imperial College Healthcare . Its unique, password-protected features include a decision-support system to help prescribers choose the right anti-infective treatment for patients, and a clinical calculator to help with accurate and safe prescribing of medicines. The app was developed by Imperial College Healthcare NHS Trust's antibiotic review group and the national Centre for Infection Prevention and Management (CIPM). It was launched to coincide with the intake of new junior doctors – 82 per cent of whom use smart phones.

Professor Jon Friedland, co-director of the CIPM stated that there have been "significant [numbers of] downloads [for the App] and positive feedback from healthcare providers using the application." "[There is] strong interest from numerous other Trusts to develop an application for them."

Air quality

The London Air iPhone 'app' displays the latest air pollution levels recorded at over 100 monitoring sites in the London Air Quality Network. Features such as Maps, My Sites and Push Notifications allow members of the public to keep up to date with London's air quality wherever they are. The app was designed by the Environmental Research Group (ERG) at King's College London – London's leading air quality information and research group. The Director of the ERG, **Professor Frank Kelly**, is also Deputy Director of the MRC/HPA Centre for Environment and Health. The application depends upon the support and participation of the boroughs of London in the London Air Quality Network. The app and website have proved popular with the public, receiving 500-1000 daily hits throughout 2010. Air quality is an immediate issue for people sensitive to pollution, for example those that suffer from asthma and other respiratory conditions. Information from the London Air Quality Network assists people in limiting their exposure to peak pollution levels in the city.

Helping stroke patients get to hospital quickly

The FAST test app[15] was devised by a team of scientists at the University of Edinburgh to provide people with a simple test to spot stroke.

Experts say people are unfamiliar with stroke symptoms, which can cause a delay in sufferers receiving medical care. In many instances this delay can prove fatal or result in significant brain damage. Stroke is the third-biggest killer after heart disease and cancer in Scotland, according to Chest Heart and Stroke Scotland (CHSS), which funded development of the app. A stroke occurs when the blood supply to the brain is interrupted. This can cause weakness in the face or arms, or slurred and muddled speech. Damage can be permanent or even fatal.

The FAST test app asks users if the person can smile, if they can lift both arms and if their speech is slurred. If all these symptoms are present, the user is told to call 999. The app provides general information about different types of stroke, including causes and treatments. It also provides an option to speak to specialist nursing staff.

Dr William Whiteley (an MRC clinician scientist) and **Graeme Heron**, of the University of Edinburgh's Division of Clinical Neurosciences, devised the app.

New diagnostic tests

In the 'post-genome' era we have seen a steady increase in the use of biomarkers and genetic tests as diagnostics. MRC-supported research has led to large numbers of these tests being put into clinical practice. Many genetic disorders are rare in the population and therapies for these conditions may not be available. Nevertheless, there are usually clear benefits to patients with rare disorders of being able to confirm or exclude a tentative diagnosis, and appropriately manage their condition. Other diagnostic/screening approaches may address conditions, such as cancer, which have both a high prevalence in the population and where an early diagnosis often determines survival outcomes. In the 2010 report, we summarised research that had led to gene tests being offered for a range of eye disorders including pre-disposition to macular degeneration, a rare congenital disorder (carpenter's disease), and tests used to define conduct disorders. We also reported long-term work to bring new and significantly-improved screening tests for cervical cancer, bowel cancer and oesophageal cancer into practice. Evaluation of these screening approaches continues with the aim of improving early diagnosis for tens of thousands of patients each year. In addition, we also reported new approaches to diagnose autism and detect latent tuberculosis. There follows a set of further examples.

Blood test for the presence of prion infection (2011)

Dr Graham Jackson, at the MRC Prion Unit has led work to establish a sensitive and reliable test for the infective agent for new variant CJD in blood. Development of the test has challenged researchers in laboratories across the world, given that the infective agent is a subtly mis-folded variant of a normal human protein, and occurs at low levels in the blood. Being able to detect the infectious agent via such a test is vital to the epidemiological study of this disease, and to the development of therapies.

The test has completed initial development and is currently in the early stages of clinical evaluation. It has already been used in the clinical care of around 30 patients. The research is fully funded by the MRC.

New imaging test for dementia (2011)

Dr Chris Morris' team at the University of Newcastle demonstrated reduced activity of the dopamine transporter in post mortem human brain in patients with Lewy body dementia, and developed this in collaboration with GE Healthcare as a diagnostic brain imaging test usable in vivo. Work on developing the test was initiated in 2007 and it has now received EU marketing authorisation. GE Healthcare markets the only in vivo imaging marker for dopamine transporter levels (DaTScan™) used for several years in Europe for the diagnosis of Parkinson's disease; this has recently been approved for use in the USA.

Molecular test for CFHR5 nephropathy (2011)

Dr Daniel Gale is a Clinical Lecturer in Nephrology at Imperial College Kidney and Transplant Institute. His MRC-supported research is on the genetic causes of kidney disease and he has used linkage mapping and other techniques to identify the molecular defects responsible for two human genetic diseases: HIF2α Erythrocytosis, which results from a defect in cellular oxygen sensing; and CFHR5 nephropathy[16], which results from a defect of complement alternative pathway regulation and which is endemic in people of Cypriot ancestry. The project led to the development of a diagnostic genetic test for CFHR5 nephropathy now in clinical use in the UK and Cyprus.

SOX3 as a candidate gene for disorders of sex differentiation (DSD) (2011)

As part of collaborative work with scientists and clinicians in Australia and the USA, a group at the MRC National Institute for Medical Research (NIMR) led by **Dr Robin Lovell-Badge** showed that SOX3 could act as a male determining gene if it was expressed incorrectly in the early developing gonads in mice[17]. This led to the finding that about 20 per cent of cases of female to male sex reversal in humans (that are not due to SRY), have genome rearrangements around SOX3. This discovery has rapidly been adopted as a diagnostic tool.

The number of patients found to date with SOX3 as a likely cause of DSD is not known; this work identified three cases and several more have now been found. However, apart from SRY, this is the next most common cause of female to male sex reversal, so while still rare (1/50,000) it is significant.

Three genetic tests for disorders in DNA repair (2011)

Work from the MRC/University of Sussex Genome Damage and Stability Centre (GDSC) has underpinned a national diagnostic service for human diseases[18]. The GDSC offers a diagnostic service for xeroderma pigmentosum (incidence 1 in 250,000), and the rare conditions Cockayne Syndrome and trichothiodystropy (TTD), receiving biopsies from the national clinic at Guy's and St Thomas' Hospital, London which dealt with 29 new patients in 2010[19]. In addition, the centre has developed new cellular assays to allow diagnosis of other rare disorders, the underlying cause of which are defects in response to DNA damage; Seckel syndrome, Mosaic Variegated Aneuploidy (MVA), LIG4 syndrome, XLF dependent severe combined immunodeficiency (SCID) and Artemis-dependent SCID.

As well as establishing diagnostic tests, this research has also provided improvements to patient treatment; **Dr Mark O'Driscoll** and **Professor Penny Jeggo** at the GDSC have demonstrated that a specific subset of SCID patients are sensitive to a widely used component of bone marrow transplantation conditioning regimes[20], these results have implications for treatment and management of this category of patients and therefore early diagnosis is important.

Genetic test for Warburg Micro Syndrome (2011)

Dr Irene Aiglianis (MRC Human Genetics Unit), in conjunction with the West Midlands Regional Genetics laboratory established a genetic test for Warburg Micro syndrome. This is the only service worldwide for this rare genetic condition. Offering diagnostic and carrier testing for families has led to earlier diagnosis of Micro syndrome, and has prevented several children undergoing unnecessary cataract surgery.

Peanut allergy (2011)

Research at the University Hospital of South Manchester NHS Foundation Trust (**Professors Adnan Custovic** and **Angela Simpson**) has shown that the IgE response to peanut allergen Ara h 2 is much more predictive of clinical peanut allergy than currently used skin or blood tests based on whole peanut extract[21–22]. The test has been developed by Phadia (now Thermo Scientific) and made available in clinical practice since 2010.

Making Sense of Listening: The IMAP Test Battery (2011)

The ability to hear is only the first step towards making sense of the range of information contained in an auditory signal. Of equal importance are the abilities to extract and use the information encoded in the auditory signal. We refer to these as listening skills, or auditory processing (AP). Deficits in these skills are associated with delayed language and literacy development, though the nature of the relevant deficits and their causal connection with these delays is hotly debated.

When a child is referred to a health professional with normal hearing and unexplained difficulties in listening, or associated delays in language or literacy development, they should ideally be assessed with a combination of psychoacoustic tests, suitable for children and for use in a clinic, together with cognitive tests to measure attention, working memory, IQ and language skills. Such a detailed examination needs to be relatively short and within the technical capability of any suitably qualified professional. Current tests for the presence of AP deficits tend to be poorly constructed and inadequately validated within the normal population. They have little or no reference to the presenting symptoms of the child, and typically include a linguistic component. Poor performance may thus reflect problems with language rather than with AP. To assist in the assessment of children with listening difficulties, paediatric audiologists need a single, standardised child-appropriate test battery based on the use of language-free stimuli.

The IMAP test battery was developed at the MRC Institute of Hearing Research to supplement tests currently used to investigate cases of suspected psychoacoustic deficits. IMAP assesses a range of relevant auditory and cognitive skills and takes about one hour to complete. It has been standardised in 1500 normally-hearing children from across the UK, aged 6-11 years. Since its development, it has been successfully used in a number of large scale studies both in the UK and the USA. IMAP provides measures for separating out sensory, from cognitive contributions, to hearing. It further limits confounds due to procedural effects by presenting tests in a child-friendly game format. Stimulus-generation, management of test protocols and control of test presentation is mediated by the IHR-STAR software platform. This provides a standardised methodology for a range of applications and ensures replicable procedures across testers. IHR-STAR provides a flexible, user-programmable environment

that currently has additional applications for hearing screening, mapping cochlear implant electrodes, and academic research or teaching.

Genetic Test for 3-M Syndrome (2012)

Dr Philip Murray (The University of Manchester) an MRC clinical research fellow has sequenced the OBSL1 gene in children with 3-M syndrome[23]. 3-M syndrome is characterised by post-natal growth restriction. This development has allowed improved rates of molecular diagnosis for children affected by 3-M syndrome which can help remove diagnostic confusion. Further investigation of this rare condition has shed new light the genes implicated in the ubiquitination pathway that regulates growth[24].

Congenital Myasthenic Syndromes (2012)

Professor David Beeson, at the Weatherall Institute of Molecular Medicine reported that collaborative research with clinicians in the Department of Clinical Neurology in Oxford, and with neurologists from the UK and overseas, led in 2006 to the discovery that mutations in the gene called DOK7 is the second most common cause of Congenital myasthenic syndromes (CMS)[25], and the first definitive way of stratifying this poorly understood syndrome.

Following up on anecdotes of some patients with CMS responding to a drug called ephedrine (used to treat asthma and bronchitis), Professor Beeson decided to organise a small study testing ephedrine as a treatment. The results, published in 2010[1], showed a dramatic improvement in disability scores. For example some patients who were in wheelchairs were able to run and jump. Ephedrine and salbutamol (which acts in a similar way) are now therapies of choice for DOK7 CMS.

This has led to further work to improve the management of this condition and better understand the disease mechanism. This work is funded by the MRC and Muscular Dystrophy Campaign. Professor Beeson is a member of the Wellcome Trust funded OXION collaboration ("Ion Channels and Diseases of Electrically Excitable Cells" PI Professor Fran Ashcroft £6.4m) which involves MRC units and university researchers from Oxford and Newcastle.

The success of the work has led to the group being commissioned to provide a national service for mutation detection and treatment of congenital myasthenic syndromes, as part of a consortium chosen by the National Specialist Advisory Commissioning Service for the diagnosis of rare muscle diseases. The service provides a means for the rapid translation of discoveries in the laboratory into clinical practice.

Professor Beeson has since discovered that mutations in genes ALG2 and ALG14 are implicated in the causes of CMS[2].

New technologies

Acousto-optic laser Microscopy (2010)

A primary objective of **Professor Angus Silver's** laboratory at University College London is to understand how the brain performs parallel distributed signal processing. However, investigating information processing in the brain has been severely hampered by the limited experimental methods available for studying rapid signalling in 3D structures. To overcome these limitations, Professor Silver and Professor Peter Saggau (Baylor College of Medicine, USA) have developed a new type of optical element based on 4 acousto-optic deflectors that can focus and steer a laser beam at ~40 kHz for use with 2-photon microscopy.

This high speed 3D functional optical imaging technology enables many points of interest to be measured at kHz rates and is well suited for measuring distributed neuronal signalling. Signalling can be monitored simultaneously from more than 30 neurons distributed in 3D space with a temporal resolution greater than 1 kHz. This time scale is relevant for 'reading' spike timing-based neural population codes.

UCL Business has filed two patent applications on this technology and is hoping to license the design features of the 3D 2-photon AOL microscope. This technology has several potential applications outside neuroscience and cell biology. These include high capacity data storage, 3D lithography, laser tweezers and cold atom traps for quantum physics experiments.

Optical Projection Tomography (2011)

Optical projection tomography (OPT) is a relatively new imaging technique, developed by Dr James Sharpe at the MRC Human Genetics Unit, in 2002[3]. The aim of OPT is to accurately image the development of 3D structures. It works by projecting light through a whole specimen.

Since 2005, MRC Technology has provided 39 OPT microscope systems to laboratories around the world. These are fully supported by Quality Assurance systems in place on the Edinburgh site. MRC Technology also supports extensive training on the system. This is done mainly on-site in Edinburgh where 29 'Bioptonics'[4] courses have been provided, but also at the laboratories who have bought the system.

The system has also been a feature at the EMBO Practical Course on 3D Developmental Imaging in 2009 and 2010, and in 2011, two out of 21 winners in the Wellcome Trust image awards[5] were taken using OPT.

New Public Health Interventions

MEND intervention (2011)

The MEND intervention (Mind, Exercise, Nutrition, Do it!) for childhood obesity was developed at Great Ormond Street and University College London by groups funded in part by the MRC. MEND has been validated in randomised controlled studies which have shown it to be an effective and feasible community-based programme for childhood obesity. MEND Central Ltd was set up in 2004 as a social enterprise, and delivers programmes to 1000 centres, in more than six countries. In 2011 alone, 700 programmes were delivered and to date 60,000 individuals have participated.

Selected examples of products and interventions in development

Risk score for diabetes (2006)

Dr Simon Griffin (MRC Epidemiology Unit) has developed a risk score to identify people at high risk of having or developing type 2 diabetes which utilises data routinely held in general practice electronic records. The risk score was used to identify ~33,000 individuals at high risk (from a population of ~150,000 aged 40-69 years) who were then invited for screening for diabetes as the first stage of the ADDITION trial[6]. Details of the risk score have been requested by clinicians and policy-makers from numerous different countries.

The PACE trial (2006)

Professor Peter White (Queen Mary, University of London) conducted a Randomised Controlled Trial for treatment of chronic fatigue syndrome, including CBT, graded exercise, adaptive pacing and usual medical care.

The PACE trial treatment manuals[7], published in March 2011, are free for download and use by clinicians around the world.

Clinicians have reported that they have used them and found them helpful. Some are being translated into other languages.

Liver Support Device (2011)

Dr Nathan Davies' (University College London) research has led to the development of a simplified configuration of the UCL-ARSeNEL liver support device[8]. Funded by an MRC grant in partnership with Gambro GmbH, the new device design uses only two filters rather than three and will now work with a standard dialysis machine. This has two major benefits: 1. That the risk of blood clotting complications has significantly decreased; and 2. That the liver support device will work with existing hospital-based technology and not require additional equipment to be purchased. It is hoped that this will increase the chances of successful commercialisation.

Gel-based swallowing aid (2012)

Professors Duncan Craig and **David Wright** (University of East Anglia) have developed a gel-based swallowing aid whereby a tablet is inserted prior to swallowing. While a prototype (and associated IP application) was in place prior to the MRC (DPFS) award, the formulation has been refined in the course of the project. The team is about to commence a healthy volunteer trial to establish bioequivalence.

Oral desensitisation for peanut allergy (2011)

Dr Pamela Ewan (University of Cambridge) conducted a trial for a new treatment for peanut allergy, funded by NIHR, in 2010. Peanut allergy is the commonest cause of fatal food-allergic reactions, population studies show it affects two per cent of children, meaning tens of thousands of UK children are at risk. The MRC-funded pilot study[9] cured all 18 participants of their allergy and received significant media coverage.

The Greenbottle Pharmacy project (2011)

Professor David Pritchard (Nottingham University) has shown that an enzyme from the greenbottle fly may improve the management of leg ulcers[10]. A prototype formulation outperforms the current treatment for removing necrotic tissue, and researchers are now scaling-up for clinical evaluation. This work is supported by an MRC DPFS Portfolio Award, and builds on previous support from Wellcome Trust, DSTL, EPSRC and TSB.

Reduction of HCV infection (2007)

Dr Arvind Patel (Glasgow Centre for Virus Research) has shown that antibody MAb AP33 recognises a highly conserved linear region of the hepatitis C virus E2 glycoprotein which is essential for virus entry into target cells. This antibody blocks the interaction of E2 with CD81, a cellular receptor essential for virus entry. It also neutralises infection of cells with diverse viral genotypes and subtypes. Given its broadly neutralising properties, MAb AP33 was humanised in collaboration with the MRCT Therapeutic Antibody Group and licensed to a major pharma company for its development as a therapeutic agent.

The humanised MAb AP33, called MRCT10, is expected to be of direct clinical benefit for passive immunotherapy to reduce the risk of HCV infection after needlestick or other accidental exposure, and in the liver-transplant setting to reduce the incidence of graft re-infection. Furthermore, given its broadly neutralising properties, the epitope recognised by MAb AP33/MRCT10 can be considered a valid lead for vaccine design.

Huntington's disease (2009)

In 2009, **Professor David Rubinsztein** (University of Cambridge) found that Rilmenidine, an antihypertenisve drug, can induce autophagy and thereby remove mutant huntington. This attenuates the severity and delays onset of disease in a mouse model of this disease. A safety trial in Huntington's disease patients is planned.

Pain modulation in spinal cord injury patients (2011)

Dr Aleksandra Vuckovic (University of Glasgow) has developed neurofeedback for the voluntary modulation of brain waves in spinal cord injury patients with neuropathic pain. Using a Graphical User Interface, patients get online information of their brain activity in the brain areas related to pain and learn how to modulate it at will. This results in instantaneous decrease of pain. The treatment is in an early clinical assessment phase.

HDACi for treatment of Friedreich's ataxia (2012)

Having shown that the GAA-triplet repeat expansion which occurs in the neurodegenerative disease, Friedreich's ataxia, can induce heterochromatin-mediated silencing, **Professor Richard Festenstein** (MRC Clinical Sciences Centre) identified histone deacetylase inhibitors (HDACi) that can overcome such silencing in cells from patients.

Professor Festenstein is investigating this finding as a potential treatment with help from an MRC DPFS grant and support from Ataxia UK and the EU FP7 programme. In 2012, clinical trials of HDACi RG2833 were underway. RG2833 has been awarded orphan drug designation by the U.S. Food and Drug Administration and the EMA.

Respiratory pacemaker (2012)

Together with collaborators at UCL and the University of Newcastle, **Dr Ivo Lieberam** (King's College London) is in the initial stages of developing a new type of respiratory pacemaker device. The device will consist of ES cell-derived neural tissue (motor neurons and glia), as well as optoelectronic elements and will be used to drive respiration in patients who have lost control of their diaphragm muscle due to neurodegenerative disease, such as motor neurone disease. It is estimated that the technology will take approximately 10-15 years to develop; however, it is likely to result in a significant improvement to patients' quality of life. As a new body/machine interface, the likelihood is that it will have other applications.

Vitamins and cofactors as treatment of mitochondrial disease (2012)

Professor Shahmima Rahman (University College London) is currently investigating treatment strategies for mitochondrial disorders and has identified patients with a genetic condition who have been responsive to supplementation with a vitamin or cofactor, namely those with riboflavin transporter defects, disorders of coenzyme Q10 biosynthesis and cerebral folate deficiencies (folate receptor defects).

Clinical improvement in patients who previously had a rapidly progressive course has been demonstrated.

Campath - a new treatment for MS (2013)

Alemtuzumab (Campath) is a humanised rat monoclonal antibody used for the treatment of patients with resistant chronic lymphocytic leukemia. Partly based on MRC-funded work, the antibody has recently been submitted for licensing as a landmark new treatment for relapsing remitting multiple sclerosis (MS). The origins of alemtuzumab date back to MRC-funded experiments on human lymphocyte proteins by **Professor Herman Waldmann** and colleagues in 1983. The name "Campath" derives from the pathology department of Cambridge University. **Professor Alastair Compston** (University of Cambridge) has led the clinical studies that have shown effectiveness in treatment for MS

First randomised controlled trial to show spinal cord regeneration in dogs (2012)

Professor Robin Franklin and colleagues at the Wellcome Trust/MRC Cambridge Stem Cell Institute, University of Cambridge have shown it is possible to restore coordinated limb movement in dogs with severe spinal cord injury. In a unique collaboration between the centre and Cambridge University's Veterinary School, MRC researchers used a unique type of stem cell to regenerate the damaged part of the dogs' spines[1] The researchers are cautiously optimistic that the work could have a future role in the treatment of human patients with similar injuries if used alongside other treatments.

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researchfish

MRC Medical Research Council




Outputs, outcomes and impact of MRC research: 2012 report

10: Impacts on the private sector

Impacts on the private sector

Summary

The MRC is interested in the contribution that its research has made to the formation and growth of spin out companies. It is hoped that MRC research will lead to discoveries that can be commercially exploited and result in positive economic impacts such as employment, provision of new goods and services, and direct investment into the UK. The formation of spin out companies is one route to this. It is important that the MRC can both describe its contribution in this area and understand better the processes leading to the successful formation of spin out companies.

The MRC is not suggesting that the setting up of spin out companies per se is a measure of success. We are interested in the downstream impact realised, as a result of pursuing this route to commercialisation.

The MRC has had a spectacular track record in this area. Cambridge Antibody Technology (CAT), formed in 1989, is still noted as the only academic spin out which has resulted in the discovery of a blockbuster treatment (Humira). CAT was acquired by AstraZeneca in 2006 for £702 million, at which time CAT employed more than 300 staff.

An earlier route to commercialising MRC research was the formation of Celltech by the National Enterprise Board in 1980, which floated on the stock exchange in 1993 and was bought by the Belgian Pharmaceutical company UCB in 2004 for £1.53 billion. At that time, Celltech employed around 1,900 people, 450 of which worked in research and development.

In 2006 it was estimated that there were almost 1,250 employees in MRC spin out companies (not including Celltech Group, by then part of UCB Pharma)[1]. However, with a number of mergers and acquisitions underway, it became difficult to continue to track the contribution that MRC-funded discoveries were making to employment within these larger organisations.

MRC-funded research played a significant role in the establishment of some of the earliest biotechnology companies. For example, Biogen was formed in 1978 in Geneva by Kenneth Murray (MRC Mammailian Genome Unit, Edinburgh), Walter Gilbert (Harvard), Philip Sharp (MIT), and Charles Weissmann (Zurich). Both Gilbert and Sharp were subsequently awarded separate Nobel prizes for their contributions to genetics. Biogen is based in the US and a merger between Biogen and IDEC in 2003 formed Biogen Idec Inc. In 2010, Biogen Idec Inc. employed 4,800 staff and generated revenue of $5bn. Kenneth Murray's work, jointly with that of Heinz Schaller (Heidelberg), provided the basis of the Hepatitis B vaccine developed by Biogen, launched in 1989, and is now marketed by GlaxoSmithKline and Merck as Engerix-B™/Recombivax™. These vaccines have achieved $1bn in annual sales and Biogen has offices across the world including in the UK. Professor Sir Kenneth Murray helped establish the Darwin Trust of Edinburgh which has invested in the training of early career researchers and research infrastructure in Scotland.

MRC Technology manages and tracks commercial activity from MRC units and institutes, including spin out companies. Now via Researchfish, the MRC also collects information on links to companies that arise via its grant funding to universities, providing a comprehensive picture of these outcomes across the MRC portfolio.

The 2012 Researchfish data-gathering exercise has added to our dataset on spin out companies, and the MRC now has evidence of MRC-supported research leading to the creation or growth of 104 companies, 56 of which have been formed since 2006. It is estimated that these companies represent at least 500 new highly skilled jobs in the UK (full list later in this chapter). Data on employment in privately held companies is difficult to obtain and track, so this figure is likely to be an underestimate.

While we refer to spin out companies, in 2012 we widened the remit of this section to include feedback on significant interactions with existing private organisations (whether for profit or not-for-profit) where the strategy and/or turnover had developed directly as an output from MRC research. This information is not intended to duplicate details reported under the collaboration section which focuses on bilateral and multi-lateral exchanges of expertise/materials etc, but to capture consultancy, and technology/knowledge transfer arrangements where the transfer is primarily to the private sector.

A detailed list of all spin out companies can be found at the **Annex** to this chapter.

Status of companies with a link to MRC research in 2012

There is no accepted categorisation for spin out companies, but we have divided the set of companies into those that are selling a product (classified as 'product on market') and those without a product in the market ('developing products'). Although we acknowledge that many 'product on market' companies will also have other active programmes to develop new products, successfully bringing a product or service to market indicates the company is generating new income.

The status of companies linked to MRC research is as follows:

- 48 companies (46 per cent) had products in development (43 in the UK) and 32 (31 per cent) had products on market (28 in UK).
- Two companies (two per cent) were in stages prior to initiating a development programme (either pre-incorporation, just incorporated or seeking funding).
- Four companies had ceased trading (four per cent), and nine (nine per cent) had merged or been acquired.

Figure 1 shows the status of MRC spin out companies in 2012. The distribution of MRC spin out companies by date of formation is shown in figure 2.

Figure 1: Status of spin out companies in 2012

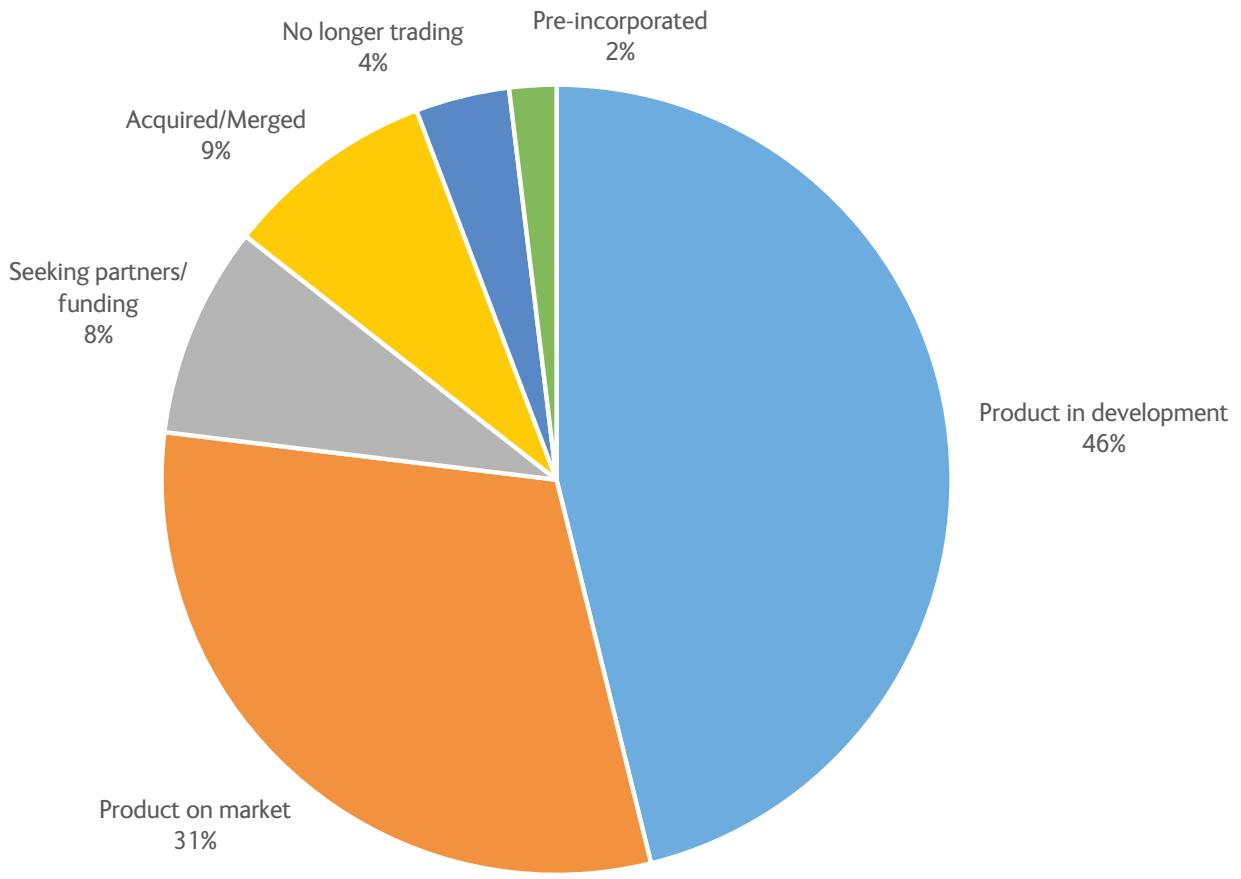
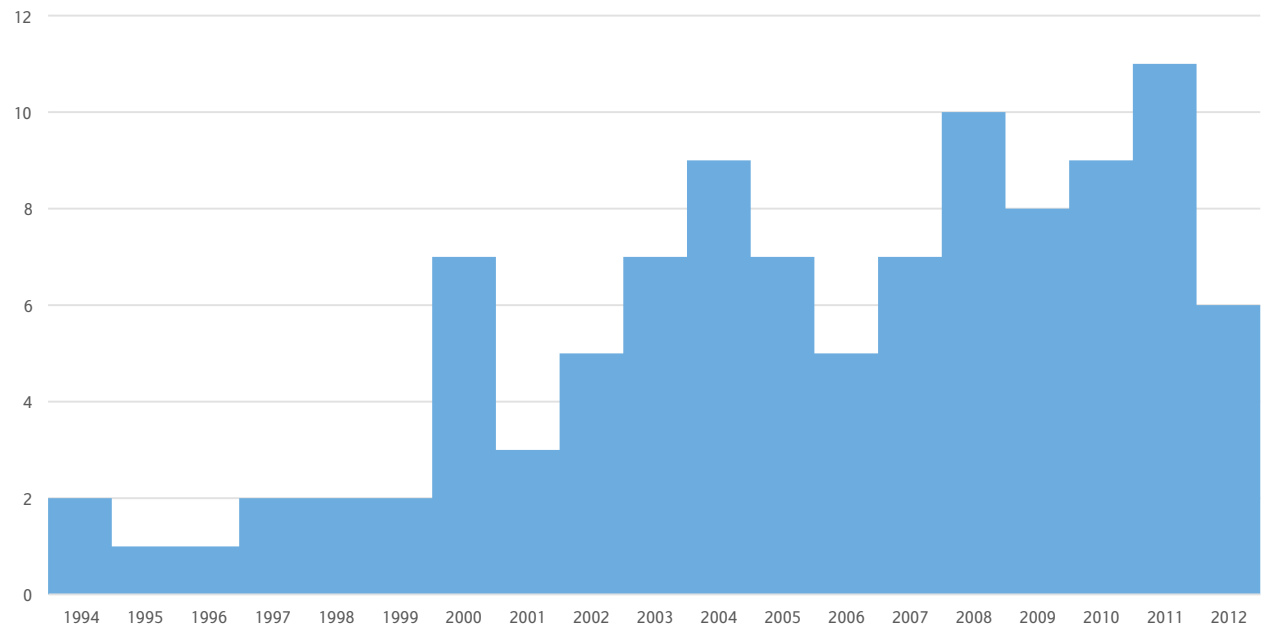


Figure 2: Date of formation of MRC spin out companies



There are nine companies that have merged with, or been acquired by, another company, representing 'exits'. The dates of these are in table 1.

Table 1: Date of exit for companies with a link to MRC research

MRC linked company	Now owned by/part of	Date of exit	Deal Value[2]
Cambridge Genetics Ltd	Galapagos group	2000	£28m
Therexsys	Vectura Group plc	2000	£20m
Domantis Ltd	GlaxoSmithKline	2001	£230m
Prolifix Ltd	Topo Target A/S	2002	merger
Ribotargets	Vernalis	2003	£25m
Oxxon Therapeutics Ltd	Oxford BioMedica	2007	£16m
Thiakis Ltd	Pfizer	2008	£100m
NovaThera Ltd	MedCell Biosciences Ltd	2008	merger
Aptuscan Ltd	Avacta Ltd	2012	£1.5m

In the Researchfish data, the details of only four companies (Ardana Biosciences, Metris Therapeutics, Sophos Therapuetics and Virogen) that have ceased trading are included. This is a low rate of failure, as studies have shown that typically 25 per cent of high-technology firms will fail in the first four years, and between 60 and 70 per cent will fail within eight to ten years[3]. A recent UK survey of university spin out companies[4] which gathered details of 820 spin outs from 150 institutions found that 73 per cent of these were more than five years old and still active, and 61 per cent were more than ten years old. This survey also notes that fewer than 10 per cent of companies have achieved a successful exit in the last 10 years, although the returns can be significant (for example, the sale of Thiakis by Imperial College).

Employment in companies with a link to MRC research

In 2010 we aimed to collect additional data on the employees in companies with a link to MRC research. It is challenging to obtain accurate data on employment within these companies, and there will be a large degree of uncertainty in this information.

Researchers were asked to select the current number of employees from a drop down of ranges (1-4, 5-9, 10-19, 20-49 etc). The lowest number in the range, for UK-based companies, is entered into this table, except where researchers provided a comment on the actual current number of employees in the company (these entries are marked *), or where we have cross referenced employment data in other sources (these are referenced).

Company	Estimated Staff
Abcodia	5
Activiomics Ltd	1
Aquila Biomedical	3[5]
Aurum Biosciences Ltd	5[6]
Bicycle Therapeutics	1
Bioscience Ventures ltd	1
Cambridge Epigenetix	1
Cambridge Neuroimaging	0
Celentyx Ltd	N/A
CellCentric Ltd	10
Celleron Therapeutics	1
Clarinnis Biosciences Ltd	2*
Cytoprom	1
DefiniGEN	1
Deliverics	1
D-Gen	1
Dioptica Scientific Ltd	1
Dundee Cell Products	5*
Edinburgh Molecular Imaging Ltd	0
EvoCell	5
FibromEd	0
Fios Genomics Ltd	2*
Gamma Technologies Ltd	0
GlycoBioChem	4[7]
Heptares Therapeutics	50
i2eye Diagnostics Ltd	N/A
Iclectus Ltd	0
Imanova Ltd	58[8]
Innovative Vector Control Consortium	20
Intellihep	1
IR Pharma	1
Kesios Therapeutics Ltd	0
Medannex Ltd	1
MesoLens Ltd	0
nanoTherics Ltd	5
NeurocentRx	1
North East Proteome Analysis Facility (NEPAF)	1
Nottingham Prognostics Ltd	1
Novocellus	N/A
Nuada Medical Group	20
Ovatus Ltd	1
Oxford Contrast Molecular Diagnostics	0
Oxford Gene Technology (OGT)	60[9]
Oxford Nanopore Technologies (ONT)	130[10]
P1 Vital	10

Pentraxin Therapeutics	0
Perspectum Diagnostics	1
Phagenesis Limited	1
Pharmatics Ltd	1
Platelet Solutions Limited	1
Pro-Cure Therapeutics Limited	10*
Promethean Particles	1
Protein Logic	N/A
Renovo	0[11]
ReOx	1
Riotech Pharmaceuticals Ltd	1
Science Capital	0
Senectus Therapeutics	1
Senexis Ltd	1
Serascience Ltd	N/A
Sesmos Ltd	5
Sophos Therapuetics	0
SubZepto Associates Consulting	0
Summit plc. (formerly VASToX)	27[12]
Synairgen	18[13]
Technicam and Medicam	0
UBiQ	1
Ubiquigent Ltd	4*
UK Biobank Ltd	32[14]
Vitrosafe System Ltd	1
Wise Monkey Foundation	1

This list identifies more than 500 employees, although the majority of these are within a small number of companies.

Significant interactions with existing private companies

Researchers reported 70 significant interactions with existing private companies. The company with the largest number of interactions was GlaxoSmithKline (10 reports), followed by Pfizer (six), and Sanofi Aventis (four).

Professor Nick Fox (University College London) reported that techniques from his MRC-funded research had been adopted by Pfizer in multi-million dollar trials involving thousands of subjects.

Professor Peter Brown (University College London) reported that his research has provided the foundation for Medtronic's research programme developing a closed loop stimulation system for Parkinson's disease.

Dr Matt Jones (University of Bristol) reported that Eli Lilly and Company has adopted the same neural network recording approaches used in his lab for drug discovery.

Professor Stefan Neubauer (University of Oxford) reported that his 3 Tesla clinical cardiovascular magnetic resonance methods have been used by Novartis in a pharmaceutical study.

Professor Paul Matthews (University of Oxford) is the vice president of integrative medicines development at GlaxoSmithKline, where he provides advice, management and leadership for product development.

Selected examples of spin out companies

UK Biobank Ltd

UK Biobank Ltd was set up in December 2003 by the Wellcome Trust and the MRC as a joint venture company, limited by guarantee and with charitable status, to oversee the implementation of the UK Biobank programme. UK Biobank has set up a trading subsidiary (UK Biocentre[15]) to use the knowledge and infrastructure developed for UK Biobank for other biomedical studies involving human volunteers.

Phagenesis Ltd

Phagenesis Ltd[16] is a spin out from the University of Manchester based partly on NHS intellectual property, and the founder Dr Shaheen Hamdy was an MRC clinician scientist. Phagenesis is a medical device company focusing on the development of technology for the assessment, treatment and management of dysphagia (swallowing problems) after strokes. In 2011 the company announced having closed a €7m series B funding round.

Raindance Technologies Inc

Raindance Technologies Inc.[17] The company is based on microdroplet 'emulsion' technology invented by Andrew Griffiths at the LMB (now at the ISIS institute, Strasbourg) combined with 'microfluidics' technology from others. It is a unique combination of engineering and biotechnology devoted to developing novel microfluidics devices that may be used for a variety of applications. The company is based in Lexington, Massachusetts, and its primary focus is on the DNA sequencing market.

Companies that may yield exciting results over the next year include **Imanova Ltd** (a new joint imaging initiative between the MRC, Imperial College, King's College and UCL).

Case studies

Heptares Therapeutics Ltd (MRC Laboratory of Molecular Biology and MRC National Institute for Medical Research)

G-protein coupled receptors (GPCRs) provide an almost universal mechanism for transmitting signals into and out of cells. There are 800 GPCRs encoded by the human genome, which are thought to produce thousands of different receptors. The few hundred that have been studied provide key functions for the senses (for example, vision and smell), homeostasis (such as blood pressure), immune regulation, cell growth (such as abnormal cell growth in cancer), and mood/behaviour. A large proportion (around 40 per cent) of all drugs marketed across all conditions act on GPCRs, making these probably the most important drug targets known.

Some of the drugs that act on GPCRs were discovered by serendipity, whereas others had elements of rational design. Examples of drugs that act on GPCRs include beta blockers (for example, Propranolol, which was the first beta blocker developed), and H2 agonists (such as cimetidine[18]). Both of these drugs were developed in the late 1960s and 1970s at ICI and GlaxoSmithKline respectively, and won the inventors a Nobel Prize in 1988. At the time, there was little known about the targets of these drugs, but researchers were able to identify compounds that interfered with these physiological processes in biochemical assays, and systematically modify these compounds, for example, to improve their action or remove toxicity.

Despite the function of around 300 GPCRs having been studied, only six GPCRs have had drugs developed for them in the past 10 years. It is clear that to pursue rational drug design, detailed structural information about GPCR, and GPCR-drug complexes is needed. However, GPCRs are large complex membrane proteins, and until recently, it has been impossible to crystallise such proteins to gain information about their atomic structure.

Until 2004, bovine rhodopsin was the only GPCR for which structural information was available, and this severely limited the understanding of the diverse GPCR family. However the role of the MRC's institutes is to tackle such long-term and seemingly intractable problems. Work at the MRC's Laboratory of Molecular Biology (LMB) had for decades been at the cutting edge of membrane protein crystallisation and structural determination techniques; Richard Henderson had published the first structure of a membrane protein, bacteriorhodopsin, in 1989 after working on this since 1973. Researchers at the MRC's National Institute for Medical Research (NIMR) had also discovered whole new classes of GPCR which are attractive candidates for modifying Alzheimer's disease.

Work at the LMB generated the idea to genetically engineer GPCRs in order to increase their stability and obtain crystals suitable for structure determination. Between 1990 and 2000, GlazoSmithKline and AstraZeneca contributed to LINK grants to develop this approach, and in 2005, Pfizer and the MRC funded 3.5 postdocs for four years to test the "StaR" approach to the thermostabilisation of receptors.

This has led to a transformation in structural data on GPCRs. In 2008, the ß1 and ß2-adrenergic receptor structures were published, in 2011 the adenosine 2A receptor with agonist and antagonist states was published, and the neurotensin receptor has been recently submitted for publication. In the past few years, eight GPCR structures have been solved, and all these structures have benefited from data provided by thermostabilised mutants. In 2013 Heptares Therapeutics published research[19] identifying the 3D structure of CRF1, the protein receptor in the brain

which controls our response to stress. This research was achieved using the intense synchrotron light produced at the Diamond Light Source[20], which is predominantly owned by the Science and Technology Facilities Council. This structural knowledge can now be applied to the determination of other GPCR structures.

Heptares Therapeutics was formed with intellectual property from the LMB and NIMR in 2007. In 2009 Heptares struck a $200m alliance with the Novartis Option Fund, focused on a single GPCR target of strategic interest to Novartis. In 2011 a four-year collaboration with AstraZeneca and MedImmune was agreed, with a focus on developing small molecule and antibody candidates targeting specific GPCRs linked to the central nervous system (CNS)/pain, cardiovascular, metabolic and inflammatory disorders. Also in 2011 Heptares agreed an approximately $100m drug discovery collaboration with Takeda, focused on a GPCR linked to CNS disorders. In 2012, Heptares granted Shire an exclusive licence to worldwide development and commercial rights to a novel small molecule adenosine A2A receptor antagonist with best-in-class potential for treating CNS disorders.

These deals represent promises of around £450m income, should milestones be met. Heptares has generated £30m of new venture capital and employs 70 staff.

Oxford Nanopore Technologies (Professor Hagan Bayley, University of Oxford)

Professor Bayley's research group developed protein pores as nanoreactors for observing chemistry at the single-molecule level. Between 2005 and 2010 Professor Bayley was funded in part by the MRC, holding a programme grant worth £920,000.

In 2005 the company, now called Oxford Nanopore Technologies, was formed as an Oxford University spin out based largely on the work of Professor Bayley, and by 2010 the company was funding positions within the Bayley laboratory.

The MRC research programme used the nanoreactor approach to carry out a detailed examination of the formation of reversible covalent Arsenic-Sulphur bonds, a reaction which is important to pharmacology, toxicology and experimental cell biology. The programme also included initial studies on droplet interface bilayers (DIB). DIBs have numerous applications including investigating the activity of single channel or pore-forming proteins and modelling various characteristics of biological tissue. In addition, the work also led to several improvements in nanopore sensing technology used for single molecule DNA sequencing. It is single molecule sequencing that is the main focus of Oxford Nanopore Technologies.

In the 2010 MRC e-Val report we noted that the company had announced it had raised a further £25m from issuing shares to existing investors, in a sixth round of funding that brought the total raised to £75m, and expanded the company from a small team to more than 95 staff. The funding is being used to develop the company's technology for nanopore DNA sequencing, protein analysis and solid-state nanopore research.

In 2012 Oxford Nanopore Technologies introduced DNA 'strand sequencing' on the high-throughput GridION platform and presented MinION, a sequencer the size of a USB memory stick[21]. The technology aims to push whole-genome sequencing to less than $1000 for the first time, and may speed up the process for delivering three billion

bases of sequence to a phenomenal 15 minutes. The process needs less sample preparation, so may be applied in the field on samples such as blood, and has applications in medicine and agriculture. The company raised a further £30m of funding shortly after this announcement.

The technology from Oxford Nanopore Technologies is being seen as transformative[22] and has generated significant interest. It is worth noting that the other leading companies in DNA sequencing — Illumina and Life Technologies — both rely on UK academic discoveries. Illumina relies on SBS sequencing which it acquired when it bought Cambridge-based Solexa in 2007[23], and Life Technologies (formed by the merger between Applied Biosystems and Invitrogen) relies on electrochemical detection of DNA, a technology licensed from DNA Electronics (a spin out from Imperial College founded by Professor Chris Toumazou)[24]. Roche has recently made a hostile takeover bid of $5.7bn for Illumina.

Endnotes

1. MRC Economic Impact Reporting Framework report 2008/09 metric 52 http://www.mrc.ac.uk/consumption/idcplg?IdcService=GET_FILE&dID=25090&dDocName=MRC006577&allowInterrupt=1
2. Deal value is the total published value of the acquisition, part of the value may be contingent upon conditions/milestones being met.
3. Growth Setbacks in New Firms (Elizabeth Garnsey & Paul Heffernan, 2003) Centre for technology management working paper (ISBN 1-902546-28-8) http://www.ifm.eng.cam.ac.uk/ctm/publications/w_papers/CTM2003-01.pdf
4. UK Spinouts survey http://www.nexxusscotland.com/news/new_spinouts_uk_survey_reveals_top_ten_universities_produce_more_half_all_uk_spinout_companies
5. As of February 2012, Aquila Biomedical has three new hires on LinkedIn http://uk.linkedin.com/company/aquila-biomedical?trk=ppro_cprof
6. Number of key staff listed on website http://www.aurumbiosciences.com/aurum/management.html
7. Number of management team http://www.glycobiochem.com/about.html
8. Details of Imanova FTE staff accessed from the Council of European Bioregions website at http://www.cebr.net/article/151
9. OGT states it has more than 60 employees http://www.ogt.co.uk/careers.htm
10. ONT states that it has more than 130 employees http://www.nanoporetech.com/about-us/summary
11. Renovo announces major restructuring http://www.renovo.com/en/news/renovo-announces-major-restructuring
12. Summit plc stated in its 2012/13 annual report (year ending 31 January 2013) that its average number of employees was 27 (16 research staff and 11 administrative staff) http://www.summitplc.com/userfiles/file/Summit-Annual-Report-2012-13.pdf
13. Synairgen plc stated in its 2012 annual report that its average number of employees was 18 (15 research and three administrative staff) http://www.synairgen.com/media/8878/15812_sy_annualreport_2012_web.pdf
14. UK Biobank 2012 annual report states that during 2011 the charity employed an average of 32 staff (27 project and five management and admin staff) http://www.ukbiobank.ac.uk/wp-content/uploads/2013/03/2012-UK-Biobank-Limited-Signed-2012-Report-and-Financial-Statements.pdf
15. UK Biocentre http://www.ukbiobank.ac.uk/uk-biocentre-2/
16. Phagenesis Ltd http://www.phagenesis.com
17. RainDance Technologies Inc. http://www.raindancetechnologies.com/about-us/molecular-biology-genome-sequencing.asp
18. Cimetideine, marketed as Tagamet, was the first pharmaceutical drug to achieve $1billion in sales.
19. Kaspar Hollenstein, James Kean, Andrea Bortolato, Robert K. Y. Cheng, Andrew S. Doré, Ali Jazayeri, Robert M. Cooke, Malcolm Weir & Fiona H. Marshall. Structure of class B GPCR corticotropin-releasing factor receptor 1, Nature DOI: 10.1038/nature12357
20. http://www.diamond.ac.uk/
21. MinION™ a miniaturised sensing instrument (Oxford Nanopore Technologies website) http://www.nanoporetech.com/technology/minion-a-miniaturised-sensing-instrument
22. Company Unveils DNA Sequencing Device Meant to Be Portable, Disposable and Cheap (New York Times, February 2012) http://www.nytimes.com/2012/02/18/health/oxford-nanopore-unveils-tiny-dna-sequencing-device.html?_r=1
23. History of Solexa Sequencing (Illumina website) http://www.illumina.com/technology/solexa_technology.ilmn
24. DNA Electronics website http://dnae.co.uk/

Annex

Name of Company	Date of formation	Company stage of development	Company summary	MRC involvement
Abcodia	2010	Seeking partners/ funding	Abcodia is a new company which will be involved in the discovery and validation of molecular biomarkers for disease diagnosis and screening. It is the means by which diagnostic, pharmaceutical and technology companies, as well as academic groups, can access serum samples collected in UKCTOCS for the purpose of ethical biomarker validation and discovery.	**Professor Ian Jacobs**, Dean of Biomedical Sciences at UCL and Principle Investigator of the UKCTOCS trial from where the serum biobank is derived established Abcodia with management support from Somaxa.
Activiomics Ltd	2010	Product in development	Activiomics provides a mass spectrometry based phosphoproteomics service to industry and has in house programs for biomarker discovery and validation.	The company's scientific founders are **Dr Pedro Cutillas** and **Professor Bart Vanhaesebroeck** from Queen Mary, University of London. Professor Vanhaesebroeck is a world leading expert in PI3K signalling (a major disease target in oncology and inflammatory diseases) and has MRC funding. Dr Cutillas is an expert in quantitative mass spectrometry and conceived the technology that is the basis of Activiomics.
Anaptys Bio Inc.	2005	Product on market (company based in the USA)	To use somatic hypermutation for antibody discovery and optimization.	In 2007, the company licensed MRC IP from **Michael Neuberger's** lab in MRC LMB, and Michael is on the Scientific Advisory Board of the company.
Aquila biomedical	2011	Seeking partners/ funding	Aquila is a preclinical services venture specilaising in turning high-end biological assays (assays based on advanced molecular understanding of disease processes) into screening tools for drug candidate selection. The initial strategy is to focus on MS, autoimmune disease, inflammation and pain.	Reported by **Professor Johnathan Seckl** (University of Edinburgh).

	News	Website
	March 2011: Collaborative partners sought for Abcodia. May 2011: Abcodia secures £1m series A funding from Albion Ventures and UCL Business Plc. November 2011: Abcodia and Oxford Gene Technology (OGT) announce a collaborative agreement aimed at improving the early detection of pancreatic cancer. February 2012: Abcodia announces collaboration with VolitionRX to discover blood-based biomarkers for cancer. December 2012: Abcodia swept the board at the Startups Awards 2012 by scooping three top prizes, as well as being honoured as the overall 'NatWest Startups Business of the Year', for its pioneering work in cancer screening.	http://www.abcodia.com/
	2010: Secured agreements with UCB and GSK to apply its technology to identify new drug targets. 2011: Secured investment from the IP group plc. 2012: Announces a research agreement with the Japanese pharmaceutical company Kyowa Hakko Kirin. Under the agreement, Activiomics will apply its novel TIQUAS phosphoproteomics platform to elucidate signalling mechanisms of lead compounds in relevant cell-based systems. This agreement was signed as part of Activiomics' strategic partnership with BioFocus.	http://www.activiomics.com/
	2007: The company secured $33 million venture capital funding. 2010: The company announced separate agreements with Roche and Merck to manufacture antibodies using the SHM platform technology 2011: AnaptysBio reported meeting key milestones with its Pharma partners, and published details of the somatic hypermutation platform in the journal PNAS. 2012: The company announced new partnerships with two Pharma partners; Novartis and an undisclosed partner.	www.anaptysbio.com/
	2012: Aquila receives support from Scottish Enterprise via its innovation support service and a SMART Scotland award. Company formally launched by the Edinburgh BioQuarter.	http://www.aquila-bm.com/index.html

Name of Company	Date of formation	Company stage of development	Company summary	MRC involvement
Aptuscan Ltd	2004	Acquired/Merged	Aptuscan has commercialised a unique engineered protein scaffold technology as a next generation alternative to antibodies. Aptuscan's 'affinity protein scaffold', mimics the behaviour of antibodies, but is much smaller, tougher and simpler to produce. The protein scaffolds can also be modified easily, to allow binding with a wide range of different molecules. Aptuscan's scaffold technology will be commercialised by Avacta under the brand name 'Affimer'.	**Dr Paul Ko Ferrigno** is founder of Aptuscan, and former group leader at the MRC Cancer Cell Unit in Cambridge. Aptuscan was a Leeds University spin out company supported by MRC Development Gap Funding and the IP group.
Ardana Biosciences	2000	No longer trading	Ardana Biosciences aimed to discover, develop and market innovative products which promote better reproductive health.	Ardana was based in part on discoveries made by the MRC Human Reproductive Sciences Unit in Edinburgh
Aurum Biosciences Ltd	2010	Product in development	Aurum has funding to develop therapeutic and diagnostic agents to clinical phase 1. Based on novel imaging and oxygen delivery technology.	Reported by **Professor Mhairi Macrae** (Glasgow University)
Axiope Ltd (now ResearchSpace)	2002	Product on market	Axiope developed the Catalyzer cataloging environment and aims to provide tools for collaboration and communication to labs. The first step in realizing that vision is eCAT, an online electronic lab notebook that allows lab members to share any kind of information, including experimental data, within the group.	Axiope Ltd was spun out as a result of the e-Science pilot project AXIOPE Grid-enabled modelling tools and databases for neuroinformatics supported by the MRC and BBSRC. It benefitted from additional funding from the DTI and Scottish Executive.
Bicycle Therapeutics	2009	Product in development	Combines the most desirable features of small molecules and biologics, to create highly specific and highly stable peptide drugs	MRC Technology spin out, based on the research of **Sir Greg Winter**, at MRC Laboratory of Molecular Biology, Cambridge

	News	Website
	2012: Aptuscan was bought for £1.48m by Avacta, another Leeds University spin out. Aptuscan's technology will continue to be developed by Avacta analytical and animal health divisions which have raised a further £5m and intends to expand beyond its current 60 staff. Dr Ferrigno has left Leeds to join Avacta.	
	Ardana floated on the stock exchange in 2005 and took products into late phase studies. Ardana went into administration in 2008.	
	In December 2010, the founders of Aurum Biosciences put in a successful bid to the RCUK business plan competition and won £10k of funding Aurum holds grants from Scottish Enterprise, the Neurosciences Foundation, and the Chief Scientist's Office in Scotland for further development of the technology at Glasgow University and clinical research into stroke at the Southern General Hospital (Glasgow). In 2012, Aurum announced an agreement with Oxygen Biotherapeutics, Inc. (OBI) that allows Aurum to develop OBI's Oxycyte PFC for diagnosis and treatment of Acute Ischaemic Stroke. The benefits of this development will be shared by the parties under the Agreement. The company is currently engaged in fund-raising to take Oxycyte into the clinic.	http://www.aurumbiosciences.com
	2005: Announces the Release of Catalyzer 2.0, to be licensed by Children's Hospital Boston 2009: e-CAT released, e-CAT is an online lab notebook for lab scientists 2010: e-CAT v3.3 released 2012: Research Innovations (operating as ResearchSpace) acquire Axiope. The Axiope management team are also involved in ResearchSpace.	
	2009: The company announced a collaboration with Pepscan Therapuetics (Netherlands) to use its constrained peptide technology for the development of new therapeutics. 2010: Signed a License agreement with the Ecole Polytechnique Federale de Lausanne (EPFL) in Lausanne, Switzerland and secured additional seed funding from SR One, the independent corporate venture fund of GlaxoSmithKline, and SV Life Sciences. 2012: Secured a tranched equity financing of £3.75 million to invest in selection of drug candidates using its bicyclic peptide technology platform. Current investors, Atlas Venture, Novartis Venture Fund, SR One and SV Life Sciences were joined by new investor Astellas Venture Management, the venture capital arm of Astellas Pharma.	www.bicycletherapeutics.com

Name of Company	Date of formation	Company stage of development	Company summary	MRC involvement
Bioptonics	2004	Product on market	Optical projection tomography (OPT) is a relatively new imaging technique, the aim of which is to accurately image the development of 3D structures. It works by projecting light through a whole specimen.	OPT was developed by **Dr James Sharpe** at the MRC Human Genetics Unit, in 2002
Bioscience Ventures Ltd	2010	Product in development	A new joint venture specialising on diagnostic test development between Alta Innovations (University of Birmingham technology transfer company) and Abingdon Health.	In 2011, Bioscience Ventures Ltd announced that it would commercialise a new urine test for adrenal cancer. The test resulted from **Professor Wiebke Arlt's** research, who led a collaborative MRC-funded study with Professor Paul Stewart at the University's Centre for Endocrinology, Diabetes and Metabolism.
Cambridge Epigenetix	2012	Product in development	Cambridge Epigenetix was spun out of Cambridge University in 2012 based on oxidative bisulfite sequencing intellectual property.	Reported by **Professor Wolf Reik** (BBSRC Babraham Institute and MRC grant holder)
Cambridge Genetics Ltd (now BioFocus DPI)	1997	Acquired/Merged	Gene-to-candidate discovery	Not known, MRC equity in this company stated in annual reports.
Cambridge Neuroimaging	2008	Product on market	The company offers a platform for the analysis of fMRI data with SPM in the form of software as a service (SaaS). Users access high-capacity hardware and software for a small subscription	The spin out utilises expertise and facilities at the MRC Cognition and Brain Sciences Unit in Cambridge
Cara Therapeutics	2007	Product in development (company based in the USA)	The company seeks novel tratments in the areas of pain and inflammation. Currently the most advanced programme is in 'phase II' clinical trials. Cara Therapeutics is based in the USA.	**Dr Graeme Milligan** (University of Glasgow) holds MRC programme grant support and is a member of the Scientific Advisory Board of Cara Therapeutics. Cara Therapeutics owns the right to exploit the 'Dimer-Screen' Technology invented by Dr Milligan.

	News	Website
	Since 2005, MRC Technology has provided 39 OPT microscope systems to laboratories around the world. These are fully supported by Quality Assurance systems in place on the Edinburgh site. MRC Technology also supports extensive training on the system. This is done mainly on-site in Edinburgh where 29 Bioptonics courses have been provided, but also at the laboratories who have bought the system. The system has also been a feature at the EMBO Practical Course on 3D Developmental Imaging in 2009 and 2010, and in 2011, two out of 21 winners in the Wellcome Trust image awards were taken using OPT.	http://www.bioptonics.com/
		http://www.abingdon-health.com/group-companies/bioscience-ventures-ltd
		http://www.enterprise.cam.ac.uk/industry/equity-portfolio/c/cambridge-epigenetix/
	2000: Cambridge University and Cambridge genetics acquired Cambridge drug discovery Ltd. 2001: BioFocus (founded by a group of Wellcome Trust funded scientists in 1997) acquired Cambridge Drug Discovery for £28m. 2005: BioFocus employs 140 staff, Galapagos acquires BioFocus for $40m. Following acquisition of several other companies, BioFocus is now a provider of integrated gene-to-candidate discovery services, employs 250 staff and has turnover of £15m. The company remains based in Cambridgeshire.	
	In 2010, Cara Therapeutics secured a further $15m venture capital funding to continue promising phase 2 studies aimed at bringing novel analgesics to market.	http://www.caratherapeutics.com/

Name of Company	Date of formation	Company stage of development	Company summary	MRC involvement
Celentyx Ltd	2007	Product in development	Celentyx is a human immune system focused R&D and service company. Celentyx's Immuno-Profiling™ platform allows rapid analysis of drug action on human immune cells. This enables partners to elucidate the mechanism of action of an immunomodulatory drug, facilitate lead candidate prioritisation or identify potentially negative impact of a drug on the human immune system prior to first administration to man. Celentyx's Novel Clinical Indication Profiling™, which applies the powerful Immuno-Profiling™ platform to the development of reprofiled drug candidates for diseases of the human immune system (for example, inflammation, autoimmune disease, allergy, graft rejection, lymphoma, leukaemia), has created an increasing portfolio of valuable drug targets.	Celentyx was founded upon research originating from the MRC Centre for Immune Regulation, situated in the University of Birmingham Medical School. The co-founders, **Professor Nicholas Barnes** and **Professor John Gordon** are experts on the way that neurotransmitters modify the immune system. They developed the company's platform technology (Immuno-Profiling™).
Cellcentric Ltd	2004	Product in development	CellCentric Ltd is focused on the exploitation of epigenetics and mechanisms that determine cell fate.	The company is based upon the research of **Professor Azim Surani FRS** at the MRC/Wellcome Trust/University of Cambridge Stem Cell initiative, and has strong links with the BBSRC Babraham Institute (for example, with **Professor Wolf Reik**)
Celleron Therapeutics	2005	Product in development	Private oncology company with several products in clinical development. Celleron aims to apply its biomarker platform, CancerNav, which predicts tumour sensitivity to new and existing therapies, to all its products and thereby provide efficacious, targeted cancer therapies which can be developed rapidly and with reduced risk.	Celleron is a spin out company from the University of Oxford. It has strong links to the new Oxford Institute of Cancer Medicine and was founded by **Professor Nicholas La Thangue**, an MRC grant holder and formerly programme leader at MRC NIMR.
Clarinnis Biosciences Ltd	2008	Product in development	Clarinnis aims to develop several applied and translational projects relating to skin biology and stem cells.	Clarinnis Biosciences Ltd is a spin out company from the University of Durham based on the research of **Professor Colin Jahoda**. Professor Jahoda has received MRC funding for this work, including a recent grant from the MRC's Translational Stem Cell Research Committee.

	News	Website
	The platform technology uses human isolated tissues and cells and has already led to the discovery of two drug candidates ready to enter phase 2 clinical trial; one for the treatment of various forms of non-Hodgkin's lymphoma (NHL is now considered the fifth most common of all cancers) and the other for the treatment of a prevalent form of epilepsy that characteristically is refractory to current medication.	http://www.celentyx.com/
	The company was founded in May 2004 with initial funding from Avlar BioVentures and Providence Investment Trust. It has since received funding from the DTI, CRUK, BBSRC, Venture capital funders, and Takeda for investigations on targets of cancers such as prostate.	http://www.cellcentric.com/
	2009: Secured exclusive rights to AstraZeneca plc's lead histone deacetylase (HDAC) inhibitor for global development in conjunction with its 'CancerNav' predictive biomarker platform 2012: Quintiles invests in a new Oxford spin out company Oxford Cancer Biomarkers to market the CancerNav platform	http://cellerontherapeutics.com/ http://www.oxfordcancerbiomarkers.com/
	Staffing reduced to one FTE employee from January 2012.	http://www.dur.ac.uk/research.commercialisation/spinouts/

Name of Company	Date of formation	Company stage of development	Company summary	MRC involvement
Creative Antibiotics	2000	Product in development (Company based in Sweden)	Creative Antibiotics is developing virulence blockers which can be alternative or complementary to current antibiotics.	**Dr Ariel Blocker** (University of Bristol) reported working with the company to provide expertise on type III secretion systems (T3SS). Gram negative bacteria use T3SS to inject virulence proteins into eukaryotic cells.
Curidium Medica Plc (now acquired by Avacta group Plc)	2006	Product in development	A small commercial enterprise based in London. Curidium is focused on identifying targeted medicines and companion diagnostics to treat patients more effectively. The Company aims to more accurately define patient subgroups with different underlying disease mechanisms and to develop targeted drug therapies for these patient subgroups.	**Professor David Collier** is on the Scientific Advisory Board for Curidium Medica. Professor Collier is Professor of Neuropsychiatric Genetics in the MRC Social Genetic, Developmental Psychiatry centre at the Institute of Psychiatry, King's College, London
Cytoprom	2011	Product on market	The aim is to sell a patented bubble excluder as part of a system to monitor cell density in fully aerated fermenters.	**Dr Edmund Kunji** (MRC Mitochondrial Biology Unit) discovered a way to shield measuring devices, such as optical probes, from the interference of air bubbles.
DefiniGEN	2012	Product in development	The company has world-leading expertise in the area of hIPSC-derived human cell production and metabolic disease modelling. The application of these technologies in drug discovery and provides pharmaceutical companies with more predictive in vitro cell products enabling the development of safer and more effective treatments. In addition the technology platform utilises fully defined and humanized conditions required for the development of regenerative medicine cellular therapies.	Definigen builds on intellectual property and knowledge resident at the University of Cambridge Regenerative Medicine Department at Addenbrokes Hospital and in addition has in-licensed the Yamanka induced pluripotent stem cell IP portfolio from iPS Academia Japan Inc. Reported by **Dr Stefano Pluchino,** Cambridge Stem Cell Initiative.

	News	Website
	Innate Pharma AB was formed in 2000, based on research from Umeå University, Karolinska Institutet and Stockholm University. The company became Creative Antibiotics in 2008. Currently, Creative Antibiotics has three projects: agents against infections in severe burns, agents against diarrhoea and agents against chlamydia infections.	http://www.creativeantibiotics.com/default.asp?LID=1
	Curidium has used its proprietary technology, Homomatrix®, to identify the very first potential companion diagnostic of its kind for schizophrenia and bipolar affective disorder. The test, called PsychINDx™, may be used to sub-classify patients into four subgroups, which are characterized by distinct gene expression profiles. Curidium announced this approach, suggesting it may ultimately lead to the development of drugs that could treat specific patient groups more effectively, in 2007. In 2009, Curidium was acquired by Avacta group plc. In 2010, Avacta group announced that Curidium had completed its strategic research alliance with Takeda Pharmaceutical Company Ltd in the area of major depression. The project had been running since late 2007.	
		http://cytoprom.com
		http://definigen.com/

Name of Company	Date of formation	Company stage of development	Company summary	MRC involvement
Deliverics Ltd	2010	Product on market	Deliverics's business is in delivering molecules into and onto cells. Cellular delivery forms the basis for many areas of research and development in the Life Sciences and is an important aspect of therapeutic treatment in many diseases. Deliverics first product SAFEctinTM has been designed to efficiently deliver RNA and DNA into cells in a very gentle and non toxic manner. Deliverics also offers bespoke chemical synthesis and purification. Deliverics launched a transfection kit focussed on the stem-cell market having worked closely with R Biomedical in August 2011	Reported by **Professor Mark Bradley** (University of Edinburgh)
D-Gen	2000	Product on market	To innovate in the field of prion-related disease by identifying, developing and exploiting proprietary diagnostic and therapeutic targets and technologies.	University spin-out company formed to commercialise relevant research emanating from the work of **Professor John Collinge**'s team at the Medical Research Council (MRC) Prion Unit (now based at the Institute of Neurology, University College London).
Dioptica Scientific Ltd	2003	Product on market	A specialist engineering company which manufactures linear dichroism accessories for use in optical spectrometers. Produces the only commercially available Couette flow cells used to take thermostatted, dynamic alignment measurements.	The product is based on work funded by the BBSRC, although **Dr Timothy Dafforn** an MRC Fellow, at the University of Birmingham has been key to developing linear dichroism techniques to the study of biological systems
Domantis Ltd (originally called Diversys Ltd now owned by GSK)	2000	Acquired/Merged	Domantis Ltd was formed to develop Human Domain Antibodies. Domain Antibodies™ (dAbs™) are therapeutic molecules that have benefits of both small molecules and conventional antibodies. Domantis is now a subsidiary of GSK.	Domantis was an MRC spin out established by **Sir Gregory Winter**, and **Dr Ian Tomlinson** from MRC LMB with seed funding from MVM Ltd.
Dundee Cell Products	2006	Product on market	Dundee Cell Products is a biotechnology products company employing 5 staff. It focusses on supplying products and tools for biochemistry and molecular and cell biology research. The company offers Quantitative Proteomics (SILAQTM) using stable isotope labeling of amino acids in culture (SILAC).	**Professor Angus Lamond** is co-founder of DCP, a Wellcome Trust Principal Research Fellow, Professor of Biochemistry at the University of Dundee and head of the Division of Gene Regulation and Expression. While Professor Lamond's laboratory is primarily funded by the Wellcome Trust, his work has also benefited from MRC grant funding.

	News	Website
	Deliverics began as a spin out from the University of Edinburgh, Department of Chemistry in April 2010. The company based its first product on the work sponsored by a Scottish Enterprise Proof of Concept project led by Dr Asier Unciti-Broceta. In November 2010 the company raised initial financing to enable the launch of its first product at the Medica International trade fair. 2011: Deliverics Ltd won the Nexxus Scotland Most Promising Young Life Science Company of the Year for the East of Scotland. A spin out from Deliverics Ltd - LIPIteq Ltd was launched to focus on the application of liposome technology to the treatment of disease. 2012: Technology Strategy Board Smart Proof of Concept grant (£60k) awarded to Deliverics Ltd to develop LIFEctin Transfection Reagent.	www.deliverics.com
	In 2007, D-Gen announced a enzymatic method for the decontamination of infectious prion material adhered to surgical steel surfaces, which is inexpensive, non-corrosive to instruments, non-hazardous to staff and compatible with current equipment and procedures used in hospital sterilization units. This successful translational development has now been licensed to the DuPont Corporation who are producing practical products to improve patient safety.	www.d-gen.co.uk
	Dioptica Scientific Ltdwas founded as a collaboration between Crystal Precision Optics and scientists at Warwick and Birmingham universities to enable engineering solutions to scientific problems to be made available to the wider community.	
	2001: Domantis secured an investment from an Australian biotechnology company Peptech 2004: Total venture capital raised by Domantis reaches $58m, the company employs 40 staff 2005: Domantis employs 44 staff 2006: GSK acquired Domantis for £230 million. MRC received £7.3 million from sale of its interest.	
	The company has carried out SILAC analysis for customers in six universities and recently gained a service contract with a large pharma company to apply this technology in their drug discovery and development process. The company has also developed various SILAC ready-to-use tissue culture media that facilitate the culture of cell lines for subsequent quantitative proteomics analysis. These special SILAC media have gained customers all over Europe and in North America. Turnover has doubled year on year for the last three years and the company has grown to eight employees (five full time and three part time).	www.dundeecellproducts.com

Name of Company	Date of formation	Company stage of development	Company summary	MRC involvement
Edinburgh Molecular Imaging Ltd	2011	Product in development	Developing a system for fluorescent microscopy through a fiber optic cable, which is relatively easy to administer in already intubated patients.	Reported by **Professor Jonathan Seckl**, University of Edinburgh.
EvoCell	2006	Seeking partners/ funding	Commercialise a platform technology which enables the reprogramming of normal somatic cells to a pluripotent state using axolotl oocyte extracts.	**Dr Andrew Johnson** is founder and scientific director of EvoCell. Dr Johnson's laboratory is funded by the Wellcome Trust and the MRC.
FibromEd	2011	Product in development	FibromEd is a tools and technologies company focussed initially on providing models of human hepatocyte biology.	FibromEd capitalises on research from the MRC Centre for Regenerative Medicine, Edinburgh. Founders include **Professor Mark Bradley** (University of Edinburgh) and **Professor John Iredale** (MRC Centre for Inflammation Research)
Fios Genomics Ltd	2008	Product in development	Fios Genomics offers computational innovative solutions to overcome challenges in genomic microarray analysis and achieve biologically insightful results rapidly. Optimised analysis solutions are applied from data generation, quality and statistical filtering to network and mechanistic pathway biology to streamline workflows for predictive accuracy and cost-effective report outputs.	Fios Genomics was founded by academics from the University of Edinburgh and the Wellcome Trust Sanger Institute, Cambridge. The founding Directors include **Drs Peter Ghazal** and **Tom Freeman** who both have held MRC funding.
Gamma Technologies Ltd	2007	Seeking partners/ funding	Gamma Technologies Ltd is a new East Midlands based company spun out from the Space Research Centre at the University of Leicester and Academic Medical Physics at the University of Nottingham. Using established expertise in the production of space instrumentation the company is developing innovative technologies for high resolution imaging systems.	Reported by **Dr John Lees** (Univeristy of Leicester).

	News	Website
	Three types of molecular probes will be used: the first will fluoresce on contact with bacteria, the second differentiates between Gram-negative and Gram-positive bacteria, and the third detects methicillin-resistant Staphylococcus aureus. These can be dispensed in micro doses (subtherapeutic amounts) into the lung and imaged in less than 15 minutes. These probes should be available for in vivo use in animals within a year, clinical diagnostics may be ready in the next five years.	http://www.edinburghsciencetriangle.com/support/emi.aspx
	2010: Research funded by the company has been submitted for publication.	www.evocell.co.uk
	2011: Biobank of phenotyped and genotyped cells for iPS development is under construction working with hospitals and Generation Scotland biobank. Hepatocytes are being validated by industry collaborations. Agreements with Generation Scotland, and Roslin Cells will underpin the growth of the company.	http://www.fibromed.co.uk
	The company has been involved in over 50 different projects and is an SME partner on a number of grants. The company currently employs the equivalent of two full time scientific posts.	http://www.fiosgenomics.com
	The company's lead product, currently at the pre-commercial prototype stage, is a Mini Gamma Ray Camera (MGRC) intended for use within intensive care and operating theatres. The camera is being evaluated at the Queen's Medical Centre, Nottingham.	http://gammatechnologies.co.uk/aboutus.html

Name of Company	Date of formation	Company stage of development	Company summary	MRC involvement
Gendaq Ltd (now owned by Sangamo Biosciences Inc.)	1999	Product in development (company based in the USA)	Sangamo BioSciences, Inc. is a US biotechnology company focused on the research and development of novel DNA-binding proteins for therapeutic gene regulation and modification.	Gendaq Ltd was based on the work of **Sir Aaron Klug**, former Director of MRC LMB and winner of the Nobel Prize for chemistry in 1982
Geneservice Ltd (now Source BioScience)	2005	Product on market		
Open Monoclonal Technology, Inc.	2007	Product on market (company based in the USA)	Open Monoclonal Technology, Inc. (OMT) is a leader in the generation and discovery of rare antibodies that are highly effective and naturally optimized by the immune system. OMT's OmniRat™ is the first transgenic rat that makes antibodies with human idiotypes as efficiently as wild-type rats make rat antibodies. OmniRat™ is based on an improved understanding of B cell development and a novel approach to inactivation of endogenous antibody expression.	OMT was founded in 2007 by Dr Roland Buelow, working closely with the lab of Marianne Brüggemann (BBSRC Babraham Institute) and scientific advisors **Michael Neuberger** (MRC LMB), Geoffrey Davis (CEO of Angelica. Therapeutics) and Ignacio Anegon (Director at INSERM). The OMT approach uses Zinc Finger Nucleases developed by Sangamo BioSciences, Inc. (a technology based on the work of **Sir Aaron Klug** former Director of MRC LMB and winner of the Nobel Prize for chemistry in 1982 to produce rats with specific gene knockouts.

	News	Website
	2001: Sangamo buys Gendaq in a deal which valued the biotech at $30 million 2005: Gendaq employs 65 staff 2007: Sir Aaron Klug and a team from Sangamo BioSciences, announced a new way to target genes that may revolutionise medical research and pave the way for new treatments. The findings were published in PNAS. The most advanced ZFP Therapeutic(TM) development program is currently in phase 2 clinical trials for evaluation of safety and clinical effect in patients with diabetic neuropathy. Phase 1 clinical trials are ongoing to evaluate a ZFP Therapeutic for peripheral artery disease. Other therapeutic development programs are focused on stem cell mobilization, ALS, cancer, HIV/AIDS, neuropathic pain, nerve regeneration, Parkinson's disease and monogenic diseases. Sangamo's core competencies enable the engineering of a class of DNA-binding proteins known as zinc finger DNA-binding proteins (ZFPs). By engineering ZFPs that recognize a specific DNA sequence, Sangamo has created ZFP transcription factors (ZFP TF(TM)) that can control gene expression and, consequently, cell function.	http://www.sangamo.com
	2005: GeneService formed from the MRC GeneServices group at the MRC HGMP, Cambridge via a management buy out. 2007:GeneService acquires the sequencing facility at the University of Oxford. Geneservice is bought by Medical Solutions for £3.86m. Medical Solutions is renamed Source BioScience.	http://www.sourcebioscience.com/
	OMT will launch OmniMouse™ in the first half of 2013 to provide species complementarity in antibody development. Both systems facilitate generation of fully human antibodies with high affinity, specificity, solubility, stability and expression without the need for further optimization. OMT refers to this as naturally optimized human antibodies™.	http://www.omtinc.net/%20OMT

Name of Company	Date of formation	Company stage of development	Company summary	MRC involvement
GlycoBioChem	2010	Pre-incorporation	GlycoBioChem is a University of Dundee biopharmaceutical spin out company focused on the discovery and development of novel small molecules for research and treatment of human diseases. The company currently markets PRODRG, software designed to generate three-dimensional models of chemicals for use in applications such as rational drug design. In addition GlycoBioChem will also market a range of unique innovative molecular and chemical tools developed specifically for research into carbohydrate processing enzymes, implicated in several diseases including cancer, Alzheimer's disease, and diabetes. GlycoBioChem is also developing a drug discovery program, currently focussed on a novel targets implicated in the development of Alzheimer's disease in collaboration with the group of Daan van Aalten at the University of Dundee.	Reported by **Professor Daan van Aalten** (University of Dundee)

	News	Website
		http://www.glycobiochem.com

Name of Company	Date of formation	Company stage of development	Company summary	MRC involvement
Heptares Therapeutics	2007	Product in development	Heptares Therapeutics is a drug discovery company focused on novel small-molecule drugs targeting G-protein-coupled receptors (GPCRs), the largest family of druggable targets. The Company has developed a unique, transformational and proprietary technology for making purified, stabilised and functional GPCRs (known as StaRs™, Stabilised Receptors), overcoming a major limiting factor to the development of new drugs targeting this group.	MRC Technology spin out based on MRC intellectual property from MRC LMB and NIMR. Heptares combines expertise that led to the landmark publication of the structure of a beta1 adrenergic receptor solved by X-ray crystallography in 2008, and knowledge of GPCR pharmacology. Several MRC patents have been filed for a variety of ideas centred on the conformational thermostabilisation of membrane proteins. These have all been exclusively assigned to Heptares Therapeutics Limited
i2eye Diagnostics Ltd	2010	Pre-incorporation	i2eye Diagnostics Ltd is a spin out from the University of Edinburgh and the Edinburgh Bioquarter. The company's mission is to develop objective eye-care tools for all patients but primarily for the benefit of previously intractible groups such as young children and those of any age with physical or mental disabilites that make it difficult for them to interact with subjective or intimidating medical equipment. Our first product is an objective, non-contact visual field analyser that will be launched in Europe and the US in 2012.	Reported by **Professor Johnathan Seckl** (University of Edinburgh)

	News	Website
	The company received seed funding from the venture capital firm MVM Life Sciences Partners LLP of some £2.2 million. In 2009, it raised a further £21 million (US$30 million) of equity finance in a successful Series A private round from three blue-chip international venture capital firms. Clarus Ventures led the syndicate, which includes the founding investor, MVM Life Science Partners, and the Novartis Option Fund. October 2009: Announced an agreement with Novartis with potential milestone payments of up to $200 million plus royalties. January 2010: Announced successful achievement of a key milestone under the agreement with Novartis. April 2011: Announced an agreement with Takeda Pharmaceutical company which includes £1.7m upfront payment, £2.8m equity stake purchased by Takeda and potential milestone payments of up to £60.5m. May 2011: Announced an agreement with Shire which includes upfront payment, plus option for potential future payments. May 2011: Announced an agreement with AstraZeneca which includes $6.25m upfront payment, committed research funding, and potential milestone payments. Heptares will also earn royalties on all discoveries made under the collaboration. 2012: Heptares grants Shire an exclusive licence to worldwide development and commercial rights to A2A antagonists discovered by Heptares. Heptares receives upfront option grant and exercise payments and is also eligible to receive future development and commercial milestone payments up to US$190 million plus royalties on product sales. 2012 Under an agreement struck with Cubist Pharmacueticals, Heptares will collaborate on up to two GPCR drug targets to be selected by Cubist. For the first target, Heptares will receive $5.5 million (USD) upfront and up to approximately $4 million in research funding plus milestones and royalties. Cubist also has the option to nominate a second GPCR target at a later point in the collaboration, which Heptares has agreed to work on according to pre-determined financials. Further terms of the agreement were not disclosed.	http://www.heptares.com/
	2013: Company raises £600k to market devices, it aims to manufacture 13 in 2013 increasing to 200 (turnover of £2m) in 2014.	http://www.i2eyediagnostics.com/

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Iclectus Ltd.	2002	Product in development	The company specialises in the research and development of antibodies. Iclectus plans to develop intrabodies as potential therapeutics for cancer and immune system disorders, and speed up the drug discovery process using a technology called Antibody-antigen Interaction Dependent Apoptosis (AIDA).	Founded by **Dr Terence Rabbitts, Dr Martin Stocks**, and MRC Technology, Iclectus is based technologies initially developed by Dr Rabbitts at the MRC LMB.
Imanova Ltd.	2011	Product on market	Imanova is a molecular and functional imaging service company.	Imanova is an innovative alliance between the MRC and three world-class London Universities: Imperial College, Kings College and University College.
Imaxio (formerly Avidis S. A.)	2000	Product on market	Avidis was formed to create immunotherapeutics through its unique protein engineering technology platform, Heptafold(R). In the course of this OverExpress® competent cells were developed for the expression of recombinant proteins. Imaxio is now an integrated biotechnology company providing drug discovery and genomic services to the industry. Based in France, Imaxio employs 20 staff.	Avidis was a spin out from the MRC and Cambridge University. Research partners include the CNRS unit Architecture et Fonction des Macromolécules Biologiques (Marseille, France), the National Institute for Medical Research (Mill Hill, London, UK), Harvard Medical School (Boston, USA) and Hôpital Universitaire de Genève (Geneva, Switzerland)
Innovative Vector Control Consortium	2005	Product in development	The IVCC is a Product Development Partnership (PDP) established as a not for profit company and registered charity to overcome the barriers to innovation in the development of new insecticides for public health vector control and to develop information systems and tools which will enable new and existing pesticides to be used more effectively	Reported by **Janet Hemingway,** Professor of Insect Molecular Biology, Director of the Liverpool School of Tropical Medicine, and MRC grant holder. Professor Hemingway is CEO of the IVCC
Intellihep	2009	Seeking partners/ funding	Exploit engineered heparins in drug discovery and biotechnology applications.	Intellihep is a spin-out company from University of Liverpool based on **Professor Turnball's** research, which is significantly funded by the MRC.

	News	Website
	2002: Iclectus received significant investment from the British Technology Group (BTG) and employed four staff.	
	Has established proof of principle for training in radiochemistry in the context of this kind of company. May 2012: Imanova is formally opened by the Minister for Science.	http://www.imanova.co.uk
	The company was re-engineered in 2004 with the purpose to focus on vaccines. In 2006, Avidis and Diagnogene joined forces to become Imaxio. Later in the year, Imaxio strengthened its presence in the protein engineering industry through the acquisition of the peptide aptamer technology assets of a French company (Aptanomics). In early 2009, Imaxio acquired Axcell Biotechnologies, a French biopharmaceutical company.	http://www.imaxio.com
	In 2010, the IVCC was awarded $50 million from the Bill & Melinda Gates Foundation to continue its work to develop new insecticides for the improved control of mosquitoes and other insects which transmit malaria, dengue and other neglected tropical diseases.	www.IVCC.com
	Company is pre-investment and is establishing a lab in 2010 and seeking further grant and investment income.	www.intellihep.com

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Intercytex	2000	Product in development	A UK Regenerative Medicine product and services company re-launced in Nov 2010. Focused on developing ICX-RHY (VAVELTA) to treat a variety of skin related problems including Epidermolysis Bullosa and scar contractures as well as providing the Cell2Therapy Translation service to other Regenerative Medicine based companies and Research Groups in order to enable them to take their cell therapy rapidly into the clinic.	**Professor Daniel Brison** (The University of Manchester) reports that joint running of GMP cleanrooms with ICX has allowed them to develop their products. Joint research on human feeder cells will potentially allow them to further develop markets for their products.
ipSOX Ltd	2011	Product on market	ipSOX produces covers for insulin pumps that come in a selection of colours and designs and stretch to fit. All ipSOX profits are reinvested to support diabetes care.	ipSOX is a collaborative company involving staff from NHS Lothian, Edinburgh Napier University and The Funky Fone Sox Company Limited.
IR Pharma	2010	Seeking partners/ funding	A contract research organisation supporting pre-clinical respiratory research	Enabled by the expertise and knowledge base within the Respiratory Pharmacology Group, Imperial College. Reported by **Professor M Belvis**i. Funded in part by Imperial College Innovations
IXICO Ltd.	2004	Product on market	Imperial College London spin out company that provides imaging services for clinical trials to the Pharmaceutical industry and is now developing a healthcare capability	IXICO was founded by academics from three leading London academic institutions, Imperial, UCL and Kings and has raised a total of £4.2m from investors. Reported by **Professor J Hajnal,** MRC Clinical Sciences Centre.
Kesios Therapeutics Ltd	2012	Product in development	Kesios will develop small molecule drug candidates that exploit a novel target for haematological malignancies, such as multiple myeloma and related indications.	The company building on the work of **Professor Guido Franzoso**, Chair in Inflammation and Signal Transduction in the Department of Medicine at Imperial College London.
Medannex Ltd	2008	Product in development	This company has been established to further develop Annnexin-A1 antibodies as novel immunosuppressant.	Reported by **Dr Fulvio D'Acquisto,** Queen Mary, University of London.

	News	Website
	Intercytex was originally founded in 2000 and listed on the Alternative Investment Market in February 2006. As a result of the recession and disappointing trial results with another product, Intercytex Group plc delisted from AIM last year and was forced to sell all of its assets. Intercytex Ltd and VAVELTA® were purchased by a private concern, Regenerative Solutions Ltd, which is now the holding company. Today Intercytex is funded in part by a series of grants from the North West Development Agency, the UK Government's Technology Strategy Board, the European Union and by an agreement with the US Department of Defence as well as private investment. Intercytex Ltd is focused on developing and marketing VAVELTA® to ensure its potential and benefits can be realised. The company is based in the Core Technology Facility in Manchester and is currently involved in two clinical trials in the UK and US.	http://www.intercytex.com/
	The company has provided over 20000 covers and is currently designing products for use in sporting activities.	www.ipsox.co.uk
	2012: IR Pharma announces an alliance with the German biotech Evotec	http://www.irpharma.co.uk
	2012: A biomedical catalyst project led by IXICO will develop a novel digital healthcare system that will enable faster, earlier and more cost effective dementia diagnosis. IXICO, Cambridge Cognition and their academic partners will build and test a prototype within the NHS and demonstrate its value before developing a refined prototype that can be rolled-out nationally.	www.ixico.com
	July 2012, Imperial Innovations invested £0.2 million as part of a seed round in Kesios Therapeutics.	

Name of Company	Date of formation	Company stage of development	Company summary	MRC involvement
MEND Ltd	2004	Product on market	The 'Mind, exercise, nutrition and do it!' (MEND) programme tackles childhood obesity and was piloted from 2000. The MEND programme is for overweight and obese children aged between seven to 13 and their families. The intervention combines all the elements required in an effective response to child obesity including: increasing physical activity family involvement practical education in nutrition and diet behavioural change.The programme emphasises practical, fun learning to deliver sustained improvements in families' fitness levels, diets and overall health. MEND Ltd was set up as a social enterprise in 2004.	**Professor Alan Lucas** (UCL) reported the links between his MRC programme and MEND Ltd. The MEND programme was devised by researchers at Great Ormond Street Hospital and UCL Institute of Child Health.
MesoLens Ltd	2009	Seeking partners/ funding	To bring a new microscope lens to market. The Mesolens is the only microscope of its kind in the world that can show three-dimensional images within cells and tissues at the same time as showing the whole organism. The microscope can produce results in seconds rather than hours, potentially speeding up the process of drug development. It is being developed at the University of Strathclyde.	Based on the research of **Dr Brad Amos**, at MRC Laboratory of Molecular Biology.
Metris Therapuetics Ltd	1996	No longer trading	Metris Therapeutics Ltd was a University of Cambridge biotechnology spinoff that specializes in the research and development of medicines that treat gynecological or women's health disorders.	**Professor Steven K Smith** reported this spin out link to an MRC programme grant held between 2003 and 2008. The company was formed to develop medicines to treat endometriosis, menstrual pain, and menopause symptoms. Johnson & Johnson was one of Metris' major backers.

	News	Website
	The MEND programme complies with recent guidance from the National Institute for Health and Clinical Excellence (NICE). This guidance is approved by the Department of Health (DH), the Department for Culture, Media and Sport (DCMS) and the Department for Education and Sport (DfES). Unlike other responses to obesity, it is not a diet and does not encourage rapid weight loss. The MEND programme is about empowerment and it puts the child at the centre. It offers a range of ways to make life changes in physical activity, food, self-confidence and personal development. By following the MEND principles, participants grow into their weight or lose it naturally. They also build a foundation for healthy living – for life. Richard Caborn, the Minister for Sport, launched 'London on the MEND' in February 2007. It demonstrates a financial model that is replicable throughout England and Wales. Councils and PCTs each contributed one-third of project inputs – either in cash or in kind – to meet total project cost of £452,000. The remaining third was financed with a grant of £171,800 from the Community Investment Fund, administered by Sport England. MEND is the most extensive child obesity treatment programme in the UK After the successful start of 'London on the MEND', the Big Lottery Wellbeing Fund awarded £8 million to support a larger initiative throughout England over four years. This funding allows 75 local partnerships to deliver the MEND programme from 231 sites. Partnerships are primarily combinations of local authorities, PCTs, schools and leisure centre operators. Almost 20,000 families will participate in the MEND programme. More than 5,000 frontline staff will receive one-day training in childhood obesity awareness. Both projects will review the effectiveness of different models of partnership working and disseminate their findings. Best practice will be highlighted in a series of articles on the IDeA website. In 2011, it was reported that there were now 1000 MEND programmes delivered each year, and the approach had impacted upon 40,000 individuals to date. The MEND Foundation now delivers the programme internationally with activity in Australia and the USA.	http://www.mendprogramme.org/
	2010: The Mesolens prototype was exhibited at the Royal Society achieving significant media coverage 2012: The Mesolens is the subject of the prestigious Leewenhoek Lecture.	
	Metris Therapuetics was dissolved in 2009.	

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Nanosight Ltd	2004	Product on market	NanoSight visualizes, measures and characterizes virtually all nanoparticles. Particle size, concentration, zeta potential and aggregation can all be analyzed while a fluorescence mode provides speciation of labeled particles. NanoSight provides real time monitoring of the subtle changes in the characteristics of particle populations with all of these analyses uniquely confirmed by visual validation.	**Professor Ian Sargent**, University of Oxford has a long-standing collaboration with NanoSight Ltd. in which the company's technology is used to measure microvesicles and exosomes in biological fluids, in particular as a biomarker for pre-eclampsia.
nanoTherics Ltd	2007	Product on market	NanoTherics is developing and commercialising magnetic nanoparticle based products. These include novel gene and small molecule transfection technologies to facilitate research and development in gene-related diseases and disorders.	**Professor Jon Dobson** (Keele University) is a founder director of NanoTherics Ltd.
NeurocentRx	2008	Product in development	The company aims to build and commercialise a portfolio of novel therapeutic candidates, and associated diagnostic tests in part from the University of Edinburgh to address clinical needs in neurological and psychiatric disorders, with an initial focus on neuropathic pain, schizophrenia and cognitive disorders.	NeurocentRx Pharma Ltd.™ was founded by 14 academics from the University of Edinburgh. The company's portfolio is based on the academic teams of **Professors Jonathan Seckl** (CCACE co-Director), David Porteous (CCACE Group Leader), **Douglas Blackwood**, **Sue Fleetwood-Walke**r and **Malcolm Walkinshaw**, all leading teams that have been funded in part for more than 10 years by the MRC.
North East Proteome Analysis Facility (NEPAF)	2008	Product on market	NEPAF is part of Celsgroup and is a company offering analytical services. NEPAF specialises in Mass Spectrometry.	Reported by **Professor David Neal** (University of Cambridge) as a collaboration to investigate protein components of the androgen receptor signalling cascade.
Nottingham Prognostics Ltd	2012	Product in development	Research at the University of Nottingham and Nottingham Trent University with support from the NHS at Nottingham University Hospitals has developed a strategy for choosing the most appropriate treatments for breast cancer patients. The approach reduces the risks and costs of over-treatment.	Reported by **Professor Susan Huxtable**, the research at Nottingham was previously supported via an MRC DPFS award.

	News	Website
	2011: NanoSight won Technology World's 2011 Business Innovation Award and was recognised by Deloitte as the UK's Fastest Growing Biotech Company . 2012: NanoSight wins Queen's Award for Enterprise for International Trade, having achieved their 450th instrument sale with more than 400 third party papers citing NanoSight technology.	http://www.nanosight.com/
	Growing world-wide sales and >£1.5 million in equity investment.	http://www.nanotherics.com/
		http://www.neurocentrx.com/
	2007: NEPAF secures £4 million from the regional development agency One North East and the European Regional Development Fund as part of a wider economic development effort in the region and launches in 2008.	

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NovaThera Ltd. (now MedCell Biosciences Ltd/ VetCell Ltd)	2003	Acquired/Merged	NovaThera Ltd. was spun-out of Imperial College London in 2003. It specialised in pioneering applications of biomaterials and stem cell biology for regenerative medicine and tissue engineering to provide innovative therapeutic solutions.	NovaThera had a relationship with Imperial College to continue commercialisation of the current and future technologies emanating from the Tissue Engineering and Regenerative Medicine Centre (TERM), a world-class research centre combining biology, biomaterials and bio-photonics expertise. **Professor Anne Bishop** (Imperial College) reported the links between the MRC support for TERM and NovaThera.
Novocellus	2004	Product in development	To market a diagnostic test of human embryo quality with which to select embryos for transfer in clinical IVF (EmbryoSure).	The system is based on the research of **Professor Henry Leese** at the University of York and An MRC grant contributed to the development of the company.
Nuada Medical Group	2009	Product on Market	Nuada Medical Group (Nuada Medical) brings together an experienced management team, capital, and the desire to contribute to the improvement of the daily practice of healthcare – in the diagnosis and treatment of cancer.	
Ovatus Ltd	2004	Product in development	Techtran is a technology transfer company which provides services to the University of Leeds. Dr Zaed Hamady an MRC funded research fellow at the University of Leeds interested in the use of genetically engineered bacteria for the treatment of bowel disorders.	A small company was established by Techtran Ltd and Dr Simon Carding (Institute of Food Research) to support the work of this project.
Oxford Contrast Molecular Diagnostics	2009	Seeking partners/ funding	Use its platform technology to deliver phase 1 clinical trials for an MRI-visible contrast agent already proven in pre-clinical animal studies.	The founders including **Dr Daniel Anthony** and Oxford University Department of Pharmacology, benefit significantly from MRC funding.
Oxford Gene Technology (OGT)	1995	Product on market	OGT is a leader in high throughput microarray technology, used for biomarker studies and cytogenetic approaches.	OGT was founded by **Professor Edwin Southern** to exploit patented discoveries made in his laboratory at Oxford University. Professor Southern held substantial MRC programme support for more than 20 years.

	News	Website
	The DTI invested via Novathera to further regenerative medicine research. Novathera developed a novel rotating bio-processor system (NovaPod®) for stem cells with MediHealth Ltd a Hong Kong company - announced in 2007. Novathera developed TheraGlass®, a novel bioactive glass which interacts with the body's tissues to stimulate cell growth and has spawned technologies with potential uses from craniofacial reconstruction to drug delivery. In 2008, Novathera merged with MedCell Bioscience Ltd, a Newmarket-based regenerative medicine company with an interest in veterinary applications of stem cell technology. The combined company continued under the name MedCell Biosciences Ltd and is based in Cambridge.	http://www.vetcell.com/medcell-human-regenerative-therapy/
	In 2008, Novocellus secured a corporate deal with Origio a/s (formerly MediCult a/s) to fund and manage the final trials process and take responsibility for the product going forward. With successful trials and product launch, Novocellus will receive up to £4.5million in milestone payments and a 25% royalty on net sales of EmbryoSure products for the life of the patents.	http://www.angleplc.com/novocellus.asp
	The centre incorporates a Siemens Verio 3T MRI scanner and is bringing techniques that have been previously confined to clinical research into routine clinical practice in the private sector.	http://www.nuadamedical.co.uk/nm-about.html
		http://www.oxfordcontrast.com/
	The worldwide market for cytogenetics products was estimated in 2011 to be worth $400m 2012: OGT opens an office in New York to support expansion in the USA	http://www.ogt.co.uk/

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Oxford Nanopore Technologies	2005	Product in development	To develop a disruptive, proprietary technology platform for the label-free analysis of single molecules.	The company was founded by **Professor Hagan Bayley**, who is currently Professor of Chemical Biology at the University of Oxford, in partnership with IP Group plc. Professor Bayley is MRC funded and the company supports a number of postdoctoral workers in Professor Bayley's laboratory.
Oxxon Therapuetics Ltd	1999	Acquired/Merged	Oxxon was focused on the development of novel therapeutic vaccines for the treatment of cancer and infectious diseases. Oxxon's lead cancer vaccine had completed a Phase II trial in melanoma.	Oxxon was founded by a group of **MRC funded immunologists** as a spin out from University of Oxford.
P1vital	2004	Product in development	A Contract Research Organisation focusing on provide services to support experimental medicine for CNS and obesity research.	P1vital is the main route for five internationally renowned academic clinical psychopharmacology groups in the UK (based at the University of Bristol, Cardiff University, the Institute of Psychiatry, the University of Manchester and the University of Oxford) to collaborate with the private sector. All of these academic groups receive significant MRC research funding.
Pentraxin Therapeutics	2001	Product in development	Hold the intellectual property and proprietary knowledge created by the research of Professor Mark Pepys.	The MRC has funded **Professor Pepys'** research substantially for over 30 years.
Perspectum Diagnostics Ltd.	2012	Product in development	The company has been recently set-up to rapidly translate liver imaging techniques designed in the university into clinical products used on patients.	Reported by **Dr Matthew Robson**, Head of Cardiac Biophysics at the University of Oxford.
Phagenesis Limited	2007	Product in development	A medical device company focussing on the development of technology for the assessment, treatment and management of dysphagia (swallowing problems) post stroke	The company is a spin out of the University of Manchester based partly on NHS intellectual property, and involves **Dr Shaheen Hamdy**, an MRC clinician scientist.

	News	Website
	Until May 2008, the company was named Oxford NanoLabs Ltd. In 2011, the company announced it had raised a further £25 million from issuing shares to existing investors, the latest in six rounds of funding that has raised a total of £75 million. The funding will be used to develop the company's technology for nanopore DNA sequencing, protein analysis and solid-state nanopore research. In 2012, Oxford Nanopore introduces DNA 'strand sequencing' on the high-throughput GridION platform and presents MinION, a sequencer the size of a USB memory stick. The company raises a further £31m of funding, taking the total raised since 2005 to £105.4m.	http://www.nanoporetech.com
	2002: Oxxon employs 15 staff. 2004: Oxxon Pharmaccines changed its name to Oxon Therapeutics. 2005: Oxxon Therapuetics employs 35 staff. 2007: Oxxon was acquired by Oxford BioMedica for £16m.	http://www.isis-innovation.com/spinout/oxxon-pharmaccines.html
	2008: P1vital announced a pre-competitive consortium in CNS Experimental Medicine with AstraZeneca, GlaxoSmithKline, Lundbeck, Organon (part of Schering-Plough) and Wyeth. These partners would provide £4 million investment to accelerate research into mental illness.	http://www.p1vital.com
	1) SAP Inhibitors for the treatment of Amyloidosis. In 2008 Pentraxin entered into a licence agreement with GSK to develop a treatment for systemic amylodoisis using Pentraxin's small molecule combined with an antibody. 2) C-reactive protein (CRP) palindromic inhibitors for the treatment and prevention of tissue damage. In 2009 the CRP programme has attracted a Medical Research Council Developmental Clinical Studies grant of £3.9m. 3) Transthyretin depletion for treatment of hereditary systemic and senile cardiac amyloidosis. This project was granted a £3.89m Wellcome Trust Seeding Drug Discovery award in 2007 and was licensed to GSK in November 2010.	http://pentraxin.wordpress.com/
	2008: Runner up in the award for most promising start up of the year at the 7th Annual Bionow! Conference. 2010: Announces raising £2m investment. 2011: Closes 7m euros series B funding round. 2012: Awarded c. £1 million from the Wellcome Trust to extend the scope of its dysphagia treatment device, from hospitals into the community. Phagenyx™, the world's first treatment for acute dysphagia following stroke, awarded a CE Mark.	http://www.phagenesis.com/

Name of Company	Date of formation	Company stage of development	Company summary	MRC involvement
Pharmatics Ltd	2011	Product in development	Pharmatics is a startup company developing intelligent software and providing data mining services to industries. Services that can be used to validate causal pathways that may contain therapeutic targets, and identify biomarkers that can be used as surrogate end-points in phase 2 trials. The company is also developing tools for prediction of individual response from high-dimensional -omic measurements.	Reported by **Professor Paul McKeigue**, University of Edinburgh
Platelet Solutions Ltd	2011	Product in development	Platelet Solutions Ltd aims to use novel technology to measure platelet function simply and accurately in any clinical setting. A particular aim is to use the technology to optimize treatment of patients at-risk of heart attack or stroke with the effects of improving health care and reducing health costs. The technology will also be of diagnostic and therapeutic value in other diseases and in drug development programs.	Platelet Solutions is a proto-company being set up by **Sue Fox, Jane May** and **Stan Heptinstall** in the Division of Cardiovascular Medicine, University of Nottingham.
Pro-Cure Therapeutics Ltd	2001	Product in development	Exploit leading edge skills and understanding in the culture, isolation, handling and gene profiling of human prostate cancer stem cells.	Pro-Cure Therapeutics Ltd is a spin-out company from the Yorkshire Cancer Research Unit in the Department of Biology at the University of York, a unit that has received significant funding from the MRC and other NCRI partners.
Protein Logic Ltd	2003	Product in development	Unlike most diagnostic tests that measure only a single or a small number of proteins, ProteinLogic utilises an monoclonal antibody biochip (ImmiChip) combined with high-throughput multiplexing technology to measure multiple blood proteins in parallel. Pattern recognition software developed at Cambridge University is then used to analyse databases of protein profiles to generate disease-specific diagnostic barcodes or 'fingerprints'.	The technology was developed by **Dr César Milstein** and **Dr Adrian Woolfson** at the MRC Laboratory of Molecular Biology in Cambridge and Professor Nick Hales from the Department of Clinical Biochemistry at the University of Cambridge. The technology is based partly on Milstein's discovery of immune cell surface antigens and his work on monoclonal antibodies, for which he was awarded the Nobel Prize in Medicine and Physiology. The research was initially funded by an MRC Development Gap Grant, a Cambridge University Challenge Fund Grant and a Department of Trade and Industry (DTI) government SMART award. Following this, the company has completed three successful private placements.

	News	Website
	Pharmatics is a young R&D company. It is working on a pilot project with a company listed on FTSE100. In July 2011, Pharmatics was announced the overall winner of BioQuarter Innovation Competition 2011, showing a potential for becoming one of the most promising young bio-medical companies in Scotland.	www.pharmaticsltd.co.uk
	2010: Wins the BioPharm 2020: UK - India Biotechnology Business Challenge. The award provides the equivalent of £40,000 business start-up funding. 2011: Wins the Start Up Award in Medilink East Midlands Business Competition. Award of an MRC DPFS grant leads to incorporation. 2012: Wins a contract with the Technology Strategy Board after submitting an application to the Board's Stratified Medicines 2: Diagnostics for adverse or non-response competition.	http://www.plateletsolutions.co.uk
	Negotiation for alliances with major Pharma companies in the Stem cell field are at an advanced stage, and bids for large scale VC funding for preclinical and clinical studies have passed an initial due diligence. Two research collaborations with International Pharma have already been completed. Pro-Cure Therapeutics has now raised around £3m over the last four years, and most recently a final seed round of £700,000 in the last month. It has 10 scientists and a small admin and marketing staff.	http://www.pro-cure.uk.com
	2003: The University of Cambridge granted ProteinLogic Ltd a worldwide, exclusive license to commercially exploit the intellectual property owned by Cambridge University UK, Addenbrooke's NHS Trust (now Cambridge University Hospitals NHS Foundation Trust), and the MRC. 2009: Announces it had demonstrated the utility of its diagnostic technology across several different diseases and disease areas. The sensitivities and specificities make it appropriate for the company to consider validation of some of the ImmiPrint tests. 2011: Completed a successful rights issue by offering all existing shareholders the opportunity to purchase new shares in the Company. The rights issue, which raised the targeted £350,000, was heavily oversubscribed. 2012: Awarded a grant by the Technology Strategy Board to help support the development of a new Diagnostic Test for Hepatitis.	http://www.proteinlogic.com/

Name of Company	Date of formation	Company stage of development	Company summary	MRC involvement
Prolifix Ltd	1994	Acquired/Merged	Discover and develop small molecule, cell-cycle modulating drugs for cancer therapy.	Prolifix Ltd was formed in 1994 based on work from MRC's National Institute of Medical Research (NIMR) and was incubated in the MRC's London Collaborative Centre before moving to Oxford.
Promethean Particles	2008	Product on market	Providing specialised products and consultancy to the market. The Company has a unique reactor technology, to allow unprecedented product control and flexibility in inorganic nanoparticle dispersion manufacture.	Promethean Particles is a spin-out company of the University of Nottingham based on the research of **Dr Ed Lester**, reader in chemical technology at Nottingham. The company was established following a business plan competition run as part of the MRC funded inter-disciplinary bridging award to the University.
Proteome Sciences	1994	Product on market	Proteome Sciences is a global leader in applied proteomics, using high sensitivity proprietary technologies to detect biomarkers (differentially expressed proteins in diseases) and to develop rapid assays for testing. The biomarkers discovered in body fluids or tissues are validated, developed and commercialized as diagnostic, prognostic or therapeutic products through strategic alliances and out-licensing.	Proteome Sciences participated in an MRC funded study at the Institute of Psychiatry, Kings College. Together with the principal investigator, **Professor Simon Lovestone**, the company developed assays as part of this grant and have now started marketing an Alzheimer's panel resulting from the research. **Dr Diane Hanger** also at Kings College reported joint intellectual property with the company.
Pulmagen (formerly Etiologics)	2002	Product in development	Pulmagen is a development stage biotechnology company that aims to progress novel therapies to treat chronic respiratory diseases including COPD, severe asthma and cystic fibrosis.	Etiologics was set up in 2002 to commercialise the expertise in mouse genomics at the MRC Mammalian Genetics Unit, and to pursue drug development programmes in type 2 diabetes and chronic obstructive pulmonary disease.
Raindance Technologies	2005	Product on market (company based in the USA)	The company is based on microdroplet 'emulsion' technology invented by Andrew Griffiths at the LMB (now at the ISIS institute, Strasbourg) combined with 'microfluidics' technology from others. It is a unique combination of engineering and biotechnology devoted to developing novel microfluidics devices that may be used for a variety of applications. The company is based in Lexington, Massachusetts, and its primary focus is on the DNA sequencing market.	RainDance was founded by scientists from Harvard University, the MRC LMB, and the ESPCI in Paris.

	News	Website
	2002 Prolifix was bought by the Danish oncology company Topo Target A/S, which gained the drug candidate Belinostat from the merger. Belinostat shows promise in treating multiple drug resistant cancers, and is now active in 17 clinical trials. More than half of these trials are academic trials sponsored by the National Cancer Institute (US). 2005 Topotarget employs 60 staff	
	Promethean Particles was spun-out from the University of Nottingham in February 2008 after receiving seed-corn investment from the Lachesis Fund (managed by SPARK Venture Management, formerly Questor) and Catapult. The technology at the centre of Promethean Particles, the reactor, was fully developed at the University of Nottingham, including the construction of a pilot scale facility prior to company formation and is protected by a patent application that has progressed to National / Regional phase. WINNERS of the UK NanoForum & Emerging Technologies 2009 for the Business Innovation Award in the category for Materials & Devices. Promethean Particles won the LORD STAFFORD AWARD for Innovation Achieved September 2009.	http://www.prometheanparticles.co.uk
		http://www.proteomics.com/
	2001/02: Etiologics employed 15 staff 2004: Argenta (a spin out from Aventis UK Research Centre) was merged with Etiologics to form Argenta Discovery. 2005: Argenta Discovery employs 100 staff. 2010: Argenta Discovery was acquired by Galapagos BV. Argenta's repiratory development programmes will continue as new privately held company, Pulmagen.	Argenta Discovery http://www.argentadiscovery.com/about/company-history.htm Pulmagen Therapeutics Ltd http://www.mvmlifescience.com/portfolio/detail.asp?pid=6
	2009: RainDance launches first product onto the market. 2010: RainDance is recognised by the Museum of Science, Boston and the Boston Patent Law Association for its innovations and contributions to advancing the field of genetic research. 2011: RainDance Technologies raises $37.5 million in Series D Financing (taking the total raised since 2007 to more than $82 million). The Scientist highlights RainDance's ThunderStorm system as one of the top 10 the most promising innovations in 2011. The approach allows analysis of the sequence of up to 20,000 DNA regions in parallel, suited to genetic screens.	http://www.raindancetechnologies.com/about-us/molecular-biology-genome-sequencing.asp

Name of Company	Date of formation	Company stage of development	Company summary	MRC involvement
Renovo	1998	Product in development	Renovo is a biopharmaceutical product company focussing on the discovery and development of drugs to reduce scarring, improve wound healing and enhance tissue regeneration.	Renovo was founded by Professor Mark Ferguson, CEO, and Dr Sharon O'Kane. Professor Ferguson's research has in the past benefited from MRC funding.
ReOx	2003	Product in development	Discover drugs targeted on controlling the activity of hypoxia inducible factor (HIF).	The company's technology is based on the work of **Professors Peter Ratcliffe, Patrick Maxwell** and **Chris Pugh** (from the Wellcome Trust Centre for Human Genetics) combined with the expertise of Professor Christopher Schofield at the Department of Chemistry. Chris Pugh holds MRC funding.
Ribotargets (now Vernalis)	1997	Acquired/Merged	RiboTargets established an innovative drug development approach using structure-based design to improve the drug discovery process, and focused on anti-infective drugs and cancer.	The founders of RiboTargets were scientists from the MRC LMB.
Riotech Pharmaceuticals Ltd	2006	Product in development	At the core of the company is the highly developed understanding of hepatitis viral pathogenesis, immune system response and identification and understanding of the genetics and host pathway management of chronic infection.	Riotech was established to exploit the work in Viral Hepatitis undertaken at Imperial College, London and at Oxford University through the Wellcome Trust Centre for Human Genetics.
Sarissa Biomedical	2005	Product on market	A company that sells microelectrode biosensors for neurotransmitters and metabolites around the world.	**Professor Nick Dale** (University of Warwick) is inventor of the IP that underlies this company and founded it.
Science Capital	2010	Product on market	Science Capital brings together scientists and business experts, innovators and investors. Through engaging talks and lively discussions, Science Capital explores scientific and technological advances alongside the investment and legal frameworks needed to make them a commercial reality. Topics encompass innovative healthcare and biomedical technologies.	Reported by P**rofessor Michael Overdiun** (University of Birmingham)

	News	Website
	2010: Renovo announced that the Phase III trial of its scar treatment (Juvista) had failed to meet its primary and secondary endpoints. Restructuring of the company, which employs around 100 staff was initiated. 2011: Renovo completed its restructuring, and now employs no staff. One clinical programme (Prevascar) remains and results are expected in 2012.	http://www.renovo.com/
	In 2005 ReOx received $9 million further funding to continue its research programme. ReOx reached a licensing agreement with a US pharmaceutical company.	http://www.isis-innovation.com/news/news/reox-aug03.html
	2003: Ribotargets merged with British Biotech and Vernalis Group Ltd to create Vernalis. 2005: Vernalis employs 127 staff.	
	Riotech has commercial out-licence lead candidates in interferon and vaccines medicines, and will continue to focus on its HCV treatment development programme, including development of PDE12 inhibitors as antiviral agents.	http://www.riotechpharma.com/
	The company started by selling biosensors for ATP, then extending this into other purines. Currently it sells biosensors for a total of 10 analytes -the most comprehensive range in the world, and has a collaborative agreement to provide biosensors for a company in the US (Pinnacle Technology).	www.sarissa-biomedical.com
	Science Capital ran three sold out meetings in 2010 that attracted hundreds of scientists and business leaders to forge new partnerships and initiate new business propositions.	www.sciencecapital.co.uk

Name of Company	Date of formation	Company stage of development	Company summary	MRC involvement
Senectus Therapeutics	2009	Seeking partners/ funding	Senectus Therapeutics is a new venture for CRUK aimed at the development of assays and drug discovery for manipulation of cancer cell senescence.	**Professor Michael White**, an MRC funded scientist and expert on cell imaging, is part of the hand picked consortium of researchers establishing this company. However the work leading to the IP was funded by CRUK and the company is managed by the CRT Discovery committee.
Senexis Ltd	2001	Product in development	The company focuses on developing a series of patents on peptide-based amyloid aggregation inhibitors.	The company was founded by **Kelvin Stott** (Cambridge University) and **Professor Andrew Doig** (University of Manchester) who independently developed inhibitors of protein aggregation. UMIST Ventures Ltd had a key role in setting up the company which started in Manchester. The MRC has a major shareholding.
Serascience Ltd	2011	Product in development	Serascience Ltd has emerged from a joint venture between the University of Birmingham and Abingdon Health Ltd around the development of a innovative blood cancer testing kit. Currently, testing for myeloma requires patients to attend a specialist laboratory with a waiting time of several days or longer for results. This new kit will enable testing to be carried out by medical staff in under 10 minutes.	
Sesmos Ltd	2011	Product in development	Investors and co-Founders:(a) Siemens Technology Accelerator, Munich (Germany),(b) Scottish Enterprises. Co-Founder: Manfred Auer. Company mission: SESMOS Ltd links the acoustic resonator CMOS technology developed at Siemens with the single bead & single molecule screening technology developed in the Auer lab to deliver new chemical modulators for customer drug targets in a thoroughly quality controlled and quantitative process at lower costs compared to competition.	
Sophos Therapuetics	2008	No longer trading		**Dr Michael Gait** at LMB established Sophos, in anticipation of exploiting cell penetrating peptides for Duchenne Muscular Dystrophy and other conditions.

	News	Website
	The company has secured $2 million in translational funding. 2011: The company announces that it has signed a deal to screen a selection of AstraZeneca's chemical compound library to identify those which trigger a key element of cancer cell ageing.	http://www.senectustherapeutics.com/
	Senexis raised £1.4 million seed funding in 2002 from BTG plc and the Wellcome Trust Limited (formerly Catalyst BioMedica Limited). To date, Senexis has raised £6.3 million, including additional grant funding, and is now conducting development candidate selection studies. In 2009, the MRC Centre for Neuromuscular Diseases, Senexis Limited, and the Oxford MRC Functional Genomics Unit (FGU) announced that they will collaborate on the discovery of novel therapeutics for Inclusion Body Myositis (IBM). The work is funded by an MRC industry collaborative award	http://www.senexis.com/index.php
	2012: Wins the Medilink West Midlands 2012 Healthcare Business Award for Best Start-Up Company.	http://www.serascience.com/
		http://www.talentscotland.com/Workers/employers/S/SESMOS.aspx
	Sophos was disbanded in 2011.	

Name of Company	Date of formation	Company stage of development	Company summary	MRC involvement
StormBio Inc.	2006	Product in development (company based in the USA)	Drug development in the field of inflammation associated with influenza	MRC funds **Professor Hussell's** work which has been licensed to StormBio via Imperial innovations
SubZepto Associates Consulting	2008	Product on market	SubZepto provides consulting in the area of single molecule research.	**Dr Justin Molloy** at the MRC NIMR established SubZepto Associates to provide consultant services.
Summit plc (formerly VASToX)	2003	Product in development	Drug development. Eight actively partnered programmes including Phase I trials of a compound for treating Duchenne Muscular Dsytrophy	Oxford University spin out with a collaborative drug development programme. The programme in DMD therapy is based on the work of **Professor Kay Davies** who has been significantly funded by MRC for more than 20 years.
Synairgen	2003	Product in development	Discover and development therapies for respiratory diseases with a focus on asthma and chronic obstructive pulmonary disease (COPD) using an inhaled interferon approach.	The founding technology stems from at least twenty years of development in the laboratories at the University of Southampton led by Professors **Stephen Holgate**, **Donna Davies** and **Ratko Djukanovic**. This research benefited from substantial long-term support from the MRC, including an MRC Professorship held by Professor Holgate.
Technicam and Medicam	2000	Product on market	Technicam have developed a new cranial access system designed to simplify burr-holes, and facilitate the insertion of monitoring probes and external ventricular drains for use in the intensive care unit or the operating theatre - the Technicam Cranial Access System.	Reported by **Professor John Pickard** (University of Cambridge). Technicam Limited was established by a group of neurosurgeons and Centrax Limited of Newton Abbot, a precision engineering company.

	News	Website
	The agreement between Imperial College and StormBio was announced in 2007. The research has established contact with many companies in the field of immune therapeutics.	http://www.stormbio.com/
	The company has provided advice to the National Physical Laboratory and GSK.	
	2010: Announced that BioMarin Pharmaceutics would take a Summit plc owned lead compound into Phase I trials. The agreement included success based development, regulatory and sales milestone payments totalling over $160 million plus sales royalties of up to 13%. BioMarin reported in August 2010 that, although the study found no adverse effects in volunteers receiving the compound, they had failed to detect high enough levels of the compound in plasma to achieve up-regulation of utrophin, and are now examining an alternative compound. Summit aims to re-formulate SMT C1100 to make it more suitable for clinical trials. In early 2011, Summit announced a new research publication from Professor Davies and collaborators which demonstrated therapeutic benefit from administering SMT C1100 to DMD patient cells in culture, and to the mdx mouse model of the disease. December 2011: Summit announced that it had obtained $1.5m funding for a Phase I clinical trial from the Muscular Dystrophy Association, Parent Project Muscular Dystrophy, Charley's Fund, Cure Duchenne, the Foundation to Eradicate Duchenne and the Nash Avery Foundation. May 2012: Phase 1 clinical study started.	http://www.summitplc.com/
	Synairgen is a drug development company with second round venture capital funding, employing between 10 and 20 staff. Following successful preclinical and Phase 1 development of inhaled interferon beta for treatment of virus-induced asthma exacerbations the company is entering phase 2a for asthma and COPD indications after 2nd fund raising round in early 2009. Synairgen announced good progress with its clinical studies in 2010. 2012: Promising phase 2 proof of concept results for inhaled interferon beta.	http://www.synairgen.com
	The aim of the company is the development of innovative advances in the field of surgical devices. All Technicam products are patent protected and CE marked. The Technicam Cranial Access Device has received an award as a Millenium Product for innovation The indications for skull burr-holes include insertion of intra-cranial bolts, insertion of exterior ventricular drains(ventriculostomies) , insertion of ventricular catheters for shunts , drainage of chronic subdural haematomas and access for brain biopsies. Burr-holes have been traditionally performed either by using air-powered drills or by hand using a brace, perforator and spherical burr. Recently the demand for cranial access via burr-holes has increased due to the application of monitoring probes, (intra-cranial) pressure transducers, oxygen and multi-parameter sensors and micro-dialysis catheters, and the increasing use of external ventricular drains in patients with head injury and subarachnoid haemorrhage. Traditionally, burr-holes have been performed in the operating theatre. By undertaking them on the intensive care unit, however, the complications of transferring the patient to the operating theatre can be avoided.	www.technicam.co.uk

Name of Company	Date of formation	Company stage of development	Company summary	MRC involvement
Therexsys/Cobra Therapuetics/ Innovata plc (now owned by Vectura Group plc.)	1998	Acquired/Merged	Innovata plc specialised in the development of a dry powder inhaler and drug formulation technologies for the treatment of respiratory conditions. Innovata is now part of Vectura Vectura aims to develop and commercialise opportunities based on the technologies in the drug delivery field.	MRC set up Therexsys in 1998, which changed its name to Cobra Therapeutics. ML Laboratories acquired Cobra in 2000 and was itself acquired by Innovata plc (which comprised the businesses formerly known as ML Laboratories PLC, Quadrant Technologies Limited and Innovata Biomed Limited) in 2005. Innovata is based in Nottingham and specialises in the development of a dry powder inhaler and drug formulation technologies for the treatment of respiratory conditions. Innovata was acquired by Vectura plc (originally a University of Bath spin out company) in 2007 for £130m. In July 2007, Vectura moved from AIM to the Official List on the London Stock Exchange. Vectura aims to develop and commercialise opportunities based on the technologies in the drug delivery field.
Thiakis Ltd	2002	Acquired/Merged	Drug development in the field of obesity. Now part of Pfizer after Pfizer's purchase of Wyeth.	Imperial Innovations (Imperial College) spin out based on the research of **Professor Steve Bloom**, significantly funded by the MRC over the last 20 years.
UBiQ	2009	Product in development (company based in the Netherlands)	Development of tools to study the ubiquitin proteasome system	UbiQ is a spin-out of the Netherlands Cancer Institute in Amsterdam reported by **Dr B Kessler** (Oxford).
Ubiquigent Ltd	2009	Product on market	Ubiquigent markets reagents, assays, services and technologies developed by the Protein Ubiquitylation Unit of the Scottish Institute for Cell Signaling, with the first products launched in 2010.	The protein ubiquitylation unit was set up as a result of **Professor Philip Cohen's** research on the innate immune system. Professor Cohen is Director of the MRC Protein Phosphorylation Unit, at the University of Dundee, and MRCT holds a share of the company.
UK Biobank Ltd	2003	Product in development	UK Biobank Ltd was set up in December 2003 by the Wellcome Trust and the Medical Research Council as a joint venture company, limited by guarantee and with charitable status, to oversee the implementation of the UK Biobank programme.	The UK Biobank project – a long term study to support research into the separate and combined effects of genetic, environmental and lifestyle factors on human health and disease – is sponsored by the Wellcome Trust, the MRC, the Department of Health and the Scottish Executive with resources totalling £58m over seven years.

	News	Website
	2004: ML laboratories employed 88 staff, by 2005 it employed 114. 2005: Innovata plc was formed when ML Laboratories PLC acquired Quadrant Technologies Limited. The Company had over 90 employees of whom 65 were engaged in research and development, based in Nottingham. 2007: Vectura (originally a University of Bath spin out company) acquired Innovata Ltd for £130 million.	
	Thiakis raised £10 million funding in 2006, and was sold to Wyeth for £20 million followed by additional potential milestones payments totalling up to £80 million, in December 2008.	
	Novel reagents are being developed and offered to the research community, which long-term potential to be used for the discovery of clinical biomarkers. First product sales were made in 2010.	http://www.ubiqbio.com/
	Ubiquigent employed its first 3 staff in 2010. In 2012 Ubiquigent employed four staff.	http://www.ubiquigent.com
	During 2008, the charity employed an average of 35 staff (30 project and five management and admin staff) During 2009, the charity employed an average of 38 staff (33 project and five management and admin staff) In July 2010, the UK Biobank study met its target of recruiting 500,000 individuals aged 45-69 years.	http://www.ukbiobank.ac.uk/

Name of Company	Date of formation	Company stage of development	Company summary	MRC involvement
UK Biocentre	2011	Product on market	Provision of services to academic and commercial collaborators conducting studies involving human volunteers. Services are principally sample collection, processing, archiving and assay	The initiative was borne from the high level of demand from other research groups to learn from UK Biobank's experience and expertise. It does not involve the data and samples held by UK Biobank. Any profits from UK Biocentre will be put back into UK Biobank, to strengthen the Resource.
Vitrosafe System Ltd	2008	Product on market	A joint venture between IVF scientists and a manufacturer. The Company has already sold product, focussing on marketing the Vitrosafe system - designed to meet GMP standards during laboratory processing of embryos and stem cells.	The inventor works at the Newcastle Fertility Centre, which has substantial research grant funding from the MRC.
Virogen	2002	No longer trading	Virogen in-licensed two earlystage products, one at the pre-clinical stage and the other primed to enter phase II clinical trials, and tried to raise significant investment to pursue these clinical opportunities.	Virogen was hosted at the MRC Technology collaborative centre.
Wise Monkey Foundation	2012	Product on market (company based in the USA)	Wise Monkey Foundation was founded to ensure a viable ongoing framework to provide software, systems, and technology to support non government organizations that strive for the sustainable health of people, animals, and the environment.	Wise Monkey started working on data management solutions for the Global Alliance for Rabies Control (GARC) in 2012. GARC have projects in the Philippines and Indonesia with data management supported by Wise Monkey Foundation. Both rabies projects (Bali and with GARC) were initiated by recommendation from the team at the Boyd Orr Centre for Population and Ecosystem Health (University of Glasgow).

	News	Website
	First agreements in place - providing sample curation and archiving and processing of research samples collected from a clinical trial to Leukameia and Lymphoma Research	http://www.ukbiobank.ac.uk/uk-biocentre-2/
	Vitrosafe Systems expect to sell £3 million of product in 2009/10 with significant international interest and an order for £0.5m.	http://www.vitrosafe.co.uk/
	This high-risk strategy failed, as the company was unable to raise funds in an exceptionally difficult market for biotech investment in 2003. As a result, MRCT assumed control of the company and sold its assets. A very early-stage drug-discovery programme was sold to Arrow Therapeutics plc and the phase 2 candidate drug was licensed to Micrologix of Vancouver, Canada.	
		http://www.wisemonkeyfoundation.org/about.html

researchfish

MRC Medical Research Council




Outputs, outcomes and impact of MRC research: 2012 report

11: Awards and recognition






Awards and recognition

Summary

Awards, prizes, and other forms of recognition, such as being appointed to the editorial board of a journal – 'measures of esteem' – are highlighted regularly by research organisations. Measures of esteem are used internationally by some funders alongside citation analysis, peer review and research income as indicators of research quality[1].

The MRC sought details of the prizes, awards and other types of recognition received by MRC researchers in order to better understand the ways in which researchers are recognised for their contributions to academia and the wider society.

The emphasis was on collecting details of recognition that had an element of peer review and award on the basis of merit.

Recipients of 50 per cent of awards reported that their work had resulted in such formal recognition for them, or for members of their MRC-funded team. The average number of reports per award (of those reporting recognition) was five (5.42). Ten or more instances of personal recognition were reported in seven per cent of all awards. A breakdown of the number of reports of recognition per award is shown in figure 1.

In total, researchers made 11,338 reports in this section; approximately twice as many as were analysed in the 2010 report. Reports increased significantly over the period 2006 – 2012 (from 793 to 1,796 per year – see figure 2).

Figure 1: Number of instances of recognition per award

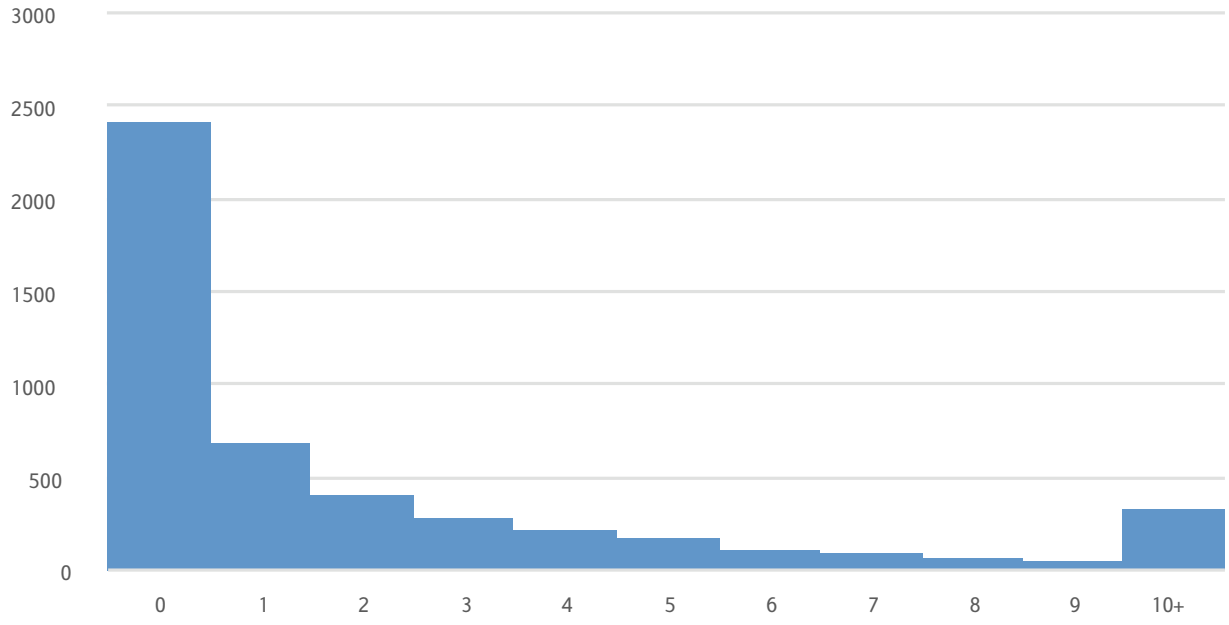
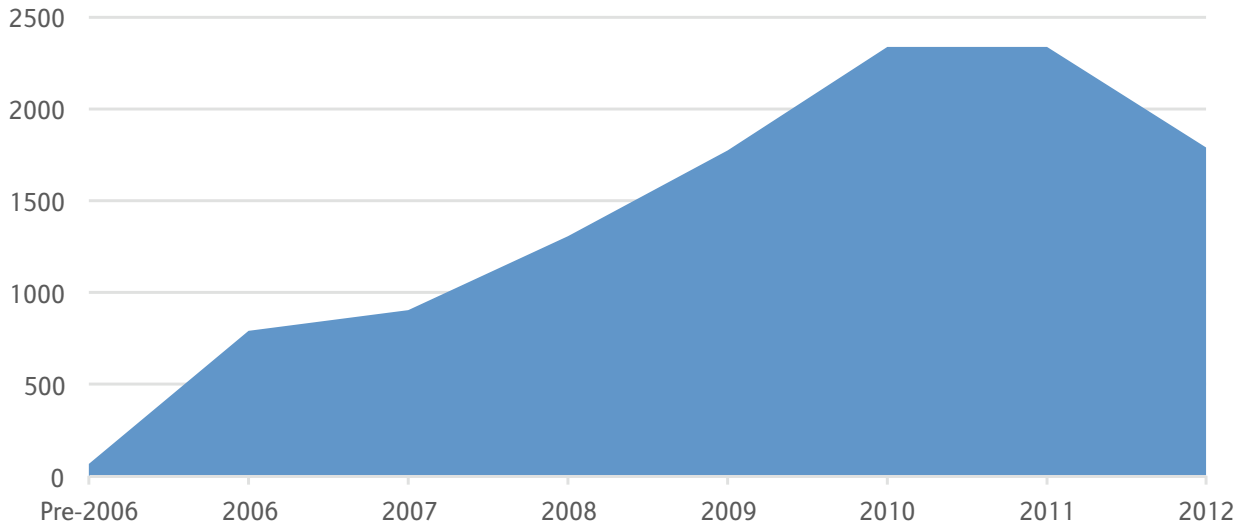


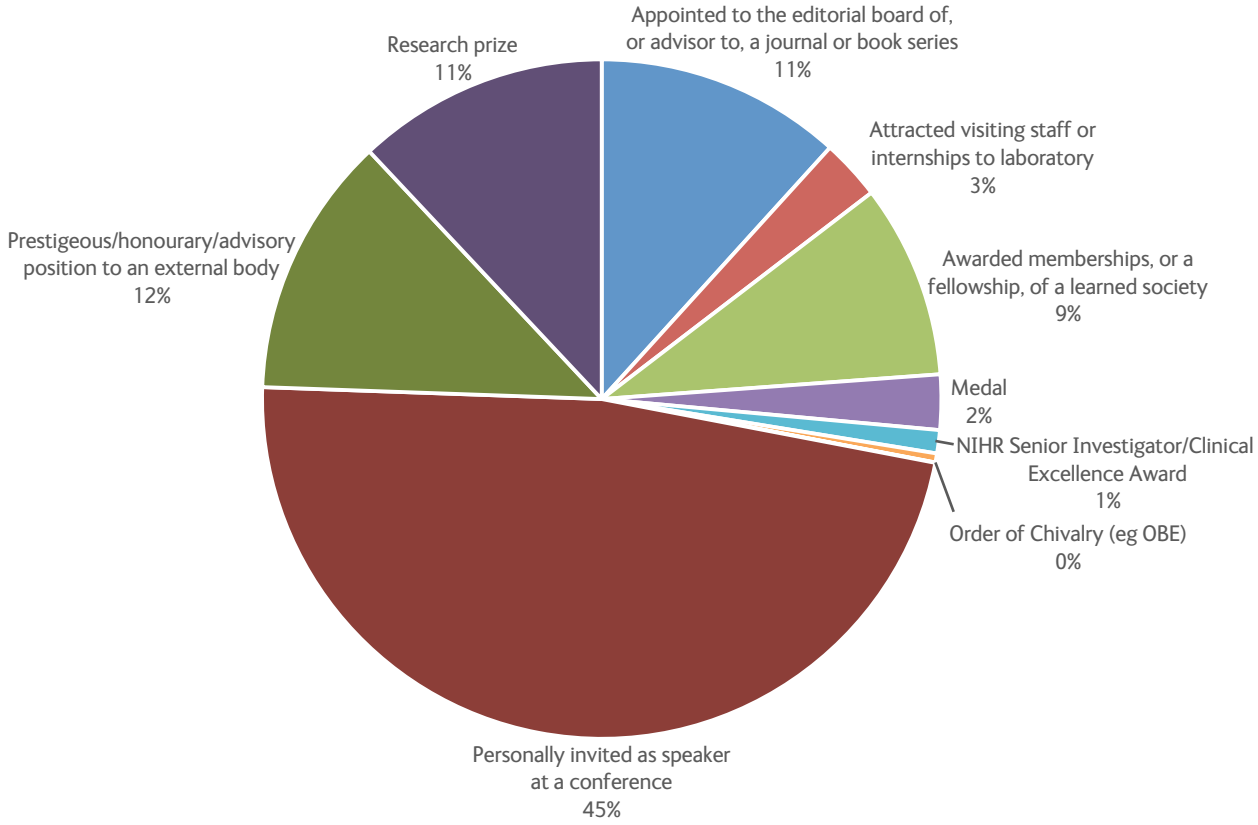
Figure 2: Reports of recognition per year[2]



Types of award and recognition received by MRC-funded researchers

The most frequently reported type of recognition was being personally invited as a speaker at a conference, in 45 per cent of awards reporting personal recognition. This was followed by being appointed to a prestigious/honorary/advisory position to an external body (12 per cent). The distribution of types of recognition is shown in figure 3.

Figure 3: Type of awards and recognition received



Appointed to the editorial board of a journal or book series

MRC-funded researchers reported 1,266 instances of being 'appointed to the editorial board of a journal or book series'. An engaged and expert editorial board is essential to the success of peer-reviewed journals[3]. Rost and Frey consider membership of the academic editorial board of a professional journal to be an integral indicator of research quality as it demonstrates a scholar's reputation and recognition amongst peers. It recognises their contributions to the research community in terms of reading and reviewing the work of others[4].

The majority of reports related to appointments to the editorial boards of journals, including prestigious publications such as Science, Cell and Nature, whilst a small number referenced editing or producing content for a book. Researchers cited significant impact from such recognition. Commonly reported was an increase in the profile of the individual concerned (but also the group and research organisation), which led to an increase in opportunities for collaboration (including internationally), career progression and an increased number of invitations to speak at conferences. Researchers also highlighted the importance of influencing the strategic direction, and scientific priorities, of the journal, and increasing the awareness of the scientific field by helping to disseminate the outputs of a particular study.

Membership of learned societies

There were 996 reports of being 'awarded membership or a fellowship of a learned society'. This included 105 researchers elected as fellows of the Academy of Medical Sciences (FMedSci), 48 as Fellows of the Royal Society (FRS), 30 Fellows of the Royal Society of Edinburgh (FRSE), and 11 as Fellows of the Society of Biology (FSB).

Each year, the Royal Society elects 44 new fellows, from a group of more than 700 nominations made by the existing fellowship, through a peer review process that culminates in a vote by existing fellows. The Academy of Medical Sciences and the Royal Society of Edinburgh both elected 46 new fellows in 2012.

As with being appointed to the editorial board of a journal, researchers reported that this recognition increased the profile of the individual and group, which led to increased opportunities for networking and collaboration, and enhanced awareness of the scientist's particular field.

Research prizes

Award holders recounted a large number of reports of prizes awarded either to the principal investigators personally, or to a member of their team (1,294). Researchers reported prizes being awarded for a variety of reasons, including posters and presentations (often made by students or early-career scientists) good science communication, academic papers and lifetime achievement.

The primary reported impact of such recognition was the increased profile of the scientist and of their work. Others received grants or invitations to present at prestigious conferences, and many reported increased career progression opportunities.

Selected examples of research prizes

British Medical Journal Research Paper of the Year 2012: Professor Kathryn Maitland (Imperial College London)

The BMJ awards help to celebrate those who make a valuable contribution towards improving the quality of healthcare.

The Fluid Expansion as Supportive Therapy Trial (FEAST) was awarded the prestigious research paper of the year award for the paper, Mortality after Fluid Bolus in African Children with Severe Infection[6], which was commended for being original research with the potential to contribute significantly to improving health and health care.

Prince of Asturias Award for scientific and technical research 2012: Sir Gregory Winter (MRC Laboratory of Molecular Biology)

The Prince of Asturias Foundation bestows the Prince of Asturias Award for scientific and technical research annually for work that represents a significant contribution to the progress and welfare of mankind.

This award was presented to Sir Gregory Winter, together with Dr Richard Lerner of the Scripps Research Institute, "for their decisive contributions to the field of immunology and, in particular, for obtaining antibodies of major therapeutic value".

Tony Pope Photography

Wellchild Researcher of the Year 2012: Professor Carol Dezateux (University College London)

The Wellchild Awards comprise an annual ceremony celebrating the bravery of some of the country's seriously ill children and the dedication of those who go the extra mile to make a difference to their lives.

"Professor Carol Dezateux has shown great passion and motivation for children's health research and demonstrated unwavering support of young researchers embarking on this career path. She has given invaluable support over a number of years for the WellChild research programme, including chairing various panels and helping to improve what we do." (Wellchild, 2012)

The Louis-Jeantet Young Investigator Career Award 2011: Dr Jason Chin (MRC Laboratory of Molecular Biology)

With this inaugural award, the Foundation intends to encourage the return to Europe, or the continued establishment there, of the best young talents in biomedical research from around the world.

Dr Jason Chin received a personal award of CHF 25,000 and an amount of CHF 400,000 for the continuation of his pioneering work on reprogramming the genetic code.

Barry Reisberg Award for Alzheimer's Research 2011: Professor Bob Woods (Bangor University)

The award, sponsored by the "I'm Still Here" Foundation, which supports the care and treatment of the five million people living with Alzheimer's disease in the United States, recognises people who have made distinguished contributions in the area of non-pharmacologic treatment for Alzheimer's disease.

Professor Bob Woods was the first international recipient and speaker at the 10th Annual Reisberg Award and Lecture.

Selected examples of other awards

NIHR Senior Investigator Awards

119 MRC-supported scientists received NIHR Senior Investigator Awards. NIHR elects the country's most preeminent leaders of clinical and applied health and social care research to be its Senior Investigators. Senior Investigators receive an award of £15,000 a year as a personal discretionary fund, and attract additional NIHR Research Capability Funding to the main NHS organisation with which they hold a contract of employment or an honorary contract.

Wellcome Trust Senior Investigator Award

Professor Matteo Carandini (University College London) was awarded a Wellcome Trust Senior Investigator Award in 2011 consisting of a grant of £1,500,000 over five years to assist his work on the integration of internal and external signals in the sensory cortex. These awards support exceptional, world-class researchers, who hold an established academic position.

IFRAD European Grand Prize for Alzheimer's Research

Professor John Hardy (University College London) was awarded the IFRAD European Grand Prize for Alzheimer's Research in 2011 in recognition of his pioneering work in identifying the biological cascade of Alzheimer's disease. The IFRAD Foundation's mission is to support clinical, patient-focused research.

European Molecular Biology Organisation (EMBO) Young Investigators Programme

Dr David Komander (Laboratory of Molecular Biology) was invited to join the European Molecular Biology Organisation (EMBO) Young Investigators Programme in 2011 and **Dr Eva Hoffmann** (MRC Genome Damage and Stability Centre, University of Sussex) was invited to join in 2012. This programme selects approximately 20 of the best young European scientists each year.

Philip Leverhulme Prize

Dr Jonathan Marchini (University of Oxford) was awarded a Philip Leverhulme Prize in 2012 for his work in statistical genetics. These prizes are awarded to outstanding scholars who have made a substantial and recognised contribution to their particular field of study, recognised at an international level, and where the expectation is that their greatest achievement is yet to come.

Attracted visiting staff or internships to laboratory

There were 310 reports of attracting visiting staff or internships. These included visiting researchers from around the world aiming to learn or refine techniques or scientific methods, and hosting those holding scholarships or fellowships and visiting collaborators.

Professor Joanna Poulton (University of Oxford) reported a visit from a scientist wishing to learn mitochondrial DNA analysis techniques, **Dr Marcelo Rivolta** (University of Sheffield) reported hosting researchers from Spain who wished to learn techniques in manipulating auditory stem cells and **Dr Shareen Doak** (Swansea University) hosted a researcher from Ghent University to give advice on how to conduct genotoxicity testing on nanomaterials. Such visits led to increased opportunities for collaboration, joint publications, and recognition of the expertise.

MRC-supported research teams attracted researchers holding various scholarships and fellowships including those awarded by the Gates Foundation, the EMBO, the Deutsche Forschungsgemeinschaft (DFG) and Fulbright Commission. A commonly cited impact was the generation of additional publications.

Orders of Chivalry

46 MRC-supported scientists reported being awarded Orders of Chivalry, which led to increased national prestige for the recipient, institution and the MRC, and enhanced networking opportunities.

Recipients in 2012 were:

Professor Sir Mark Pepys (University College London) was made a **Knight Bachelor** for **Services to Biomedicine**. His most recent work has been the invention and development of new medicines for diseases which represent unmet medical need, including amyloidosis, Alzheimer's disease, heart attacks and strokes.

Professor Julie Williams (Cardiff University) was made a **Commander of the British Empire** for **Services to Alzheimer's Research**. Her research focuses on identifying and understanding genes which increase the risk of developing complex psychological and neurodegenerative disorders.

Professor George Davey-Smith and **Professor Jean Golding** (University of Bristol) were appointed **Orders of the British Empire** for **Services to Medical Science**. Professor Golding founded the Avon Longitudinal Study of Parents and Children (ALSPAC), which is now directed by Professor George Davey-Smith. It has provided valuable genetic and environmental information since it started in 1991.

Professor Trevor Robbins (University of Cambridge) was appointed a **Commander of the British Empire** for **Services to Medical Research**. His main work focuses on the functions of the frontal lobes of the brain and their connections with other regions, including the so-called 'brain reward systems'. These brain systems are relevant to many psychiatric and neurological disorders such as Parkinson's and Huntington's disease, dementia, schizophrenia, and depression, as well as frontal lobe injury.

Endnotes

1. http://www.arc.gov.au/era/
2. A total of 11,327 unique reports were included. This excluded 11 reports where no date of the recognition had been recorded. Please note that 2012 is a partial year.
3. Eos, Vol. 94, No. 11, 12 March 2013
4. Rost, K., Frey, B.S, (2011), Quantitative and Qualitative Rankings of Scholars, *Schmalenbachs Business Review*, 63, 63-91.
5. Maitland K et al, Mortality after Fluid Bolus in African Children with Severe Infection. *N Engl J Med* 2011; 364:2483-2495 June 30, 2011 DOI: 10.1056/NEJMoa1101549

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