Research evaluation report
Outputs, outcomes and impact of BHF funded research: 2015-16
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Executive summary

Research funding
- BHF committed a total of £102.6m to 252 new grants in the 2015-16 financial year, including 88 personal awards, 125 Project Grants, 12 Programme Grants, 7 Clinical Study Grants, 2 Infrastructure Grants and 4 Translational Awards.

Academic impact of BHF research
- The academic impact of BHF research is outstanding. Cardiovascular publications from BHF funded researchers have a higher citation impact (a measure of scientific quality) than those from the whole of the UK, the rest of Europe, USA and the rest of the world.

Generation of knowledge
- 1832 research publications acknowledged BHF funding in 2015-16.
- The number of research papers published by BHF funded researchers is rising annually.
- The number of freely available full text publications is rising with 63% percent of publications in 2015-16 having open access in compliance with BHF policy.

Collaboration
- BHF funded researchers have extensive international collaborative links with researchers in the US, Europe and beyond. Almost half of research papers acknowledging BHF funding (48%, published between 2010 and 2014) had international co-authors, spread across 95 different countries.
- This collaborative research had high academic impact (resulting in a citation rate almost 4 times higher than the world average).
- Over half of BHF funded researchers reported 847 collaborations with scientists in 36 different countries, including 68 collaborations with pharmaceutical, biotechnology or other private sector organisations, arising from active grants in 2015-2016.

Translational research
- Between January 2015 and May 2016, BHF was notified of 19 new patents being filed across all awards.
- BHF award holders reported 17 unique medical products and interventions under development and the dissemination of 235 new research materials or resources to the scientific community.
- BHF’s new Translational Award scheme has funded 7 awards to progress translational research.

Influence and engagement
- BHF funded researchers reported 135 examples of activities with an influence on policy or practice.
- BHF funded research has been widely publicised in the media through press releases and other media related activities.
- Almost half of BHF funded researchers (47%) reported participating in over a thousand public engagement activities (1082).

Supporting research and researchers
- BHF has increased the length of its career development fellowships and ensured flexible working practices to improve the retention of talented scientists in academic research.
- In 2015-16, BHF awarded £13m to fund 90 new PhD students, £8.4m to fund 21 career development fellows, £4.3m to fund 4 senior research fellows and £3.4m to support 2 new BHF Professors, supporting cardiovascular researchers at all stages of their career.
Introduction
The BHF Research Strategy 2015-2020 sets out three objectives:

- To understand the social, genetic, cellular and molecular causes of cardiovascular disease
- To discover better ways of preventing, diagnosing and treating cardiovascular disease
- To enhance translation of these research discoveries into better patient care.

BHF’s strategic objectives will be attained through six approaches as shown in the figure:

- **Investing in people**: We will fund the most talented people at all career stages and seek to attract outstanding researchers from around the world.
- **Forging partnerships**: We will support research collaborations across borders and disciplines, and join forces with other funders to support more comprehensive research programmes.
- **Fighting all cardiovascular diseases**: We will support research into all forms of cardiovascular disease, whether common or rare.
- **Targeting unmet needs**: We will support research by informaticians, nurses and allied health professionals, and help build research capacity in cardiac and vascular surgery and congenital heart disease.
- **From bench to bedside and beyond**: We will continue to fund all types of research into cardiovascular disease, including laboratory studies, clinical studies and population studies.
- **Translation**: We will fund research aimed specifically at facilitating the translation of BHF-funded discoveries into patient benefit.

As part of implementing the 2015-2020 Research Strategy, the BHF is committed to measuring, reporting and demonstrating the productivity and impact of its research portfolio.

**BHF funded research has made a difference**

BHF funded research has been behind many of the major advances in cardiovascular health as related in ‘Our Research: 50 years of life saving breakthroughs’, a book published in 2011 to celebrate the BHF’s 50th anniversary. From clinical trials like the Heart Protection Study showing the benefits of statins for people at high risk of coronary artery disease to Professor Steve Humphries’ lifetime work developing genetic screening methods for familial hypercholesterolaemia, the historic successes of BHF funded research are renowned and much recounted.

**Demonstrating impact now**

What is much harder to identify and articulate is how current or recent BHF funding is making an impact on the lives of people affected by cardiovascular disease. This is particularly true for basic science research where discoveries in the laboratory may have huge translational potential, but the realisation of that potential is often far in the future and after considerable additional intellectual and financial investment. Tracking the progress of BHF funded research and its outputs over a long period of time is therefore essential to identify the impacts of the BHF’s research portfolio.

The Researchfish annual survey was adopted by BHF in 2012 to begin the process of tracking research outputs and impacts. Researchfish is an online survey database that gathers information about research outcomes and impacts directly from researchers through self-report. Grant holders
record outputs using a standardised question set for each BHF award and submit this information to BHF once a year for the lifetime of the award and for five years thereafter. The outputs recorded in Researchfish are broad, covering measures of academic impact, such as publication output and the generation and sharing of research resources, and broader impacts, such as funding leveraged as a result of the BHF award, progress to translation, capacity building and influences on policy and practice.

In 2016, in addition to reporting results from the Researchfish annual survey, the BHF commissioned Thomson Reuters (now Clarivate Analytics) to perform a bibliometric analysis measuring the citation impact of publications that acknowledge BHF funding benchmarked against cardiovascular publications from global counterparts. The aims of this analysis were to establish the academic impact and international competitiveness of BHF funded research and to assess the collaborative profile of BHF funded researchers by analysing international co-authorship of cardiovascular research papers. This provides a further indication of the standing of BHF funded researchers in an international context.

Data sources
This report includes a summary of the BHF research investment during the 2015-16 financial year taken from annual statistics produced by the Research Funds Division. Information about outputs is drawn mainly from data gathered from:
- The 2016 Researchfish submission period (see Appendix 1 for inclusion criteria)
- Publication data from the commissioned Cardiovascular Bibliometric Analysis performed by Thomson Reuters¹
- Publication data, retrieved and collated from Europe PubMed Central (Europe PMC)²
- BHF Intellectual Property Report³
- Data from the Academy of Medical Sciences report into the outputs and impacts of Clinical Starter Grants⁴

¹ Internal document; Thomson Reuters, British Heart Foundation Bibliometric Evaluation, September 2016
² Europe PMC, http://europepmc.org/
³ Internal document; British Heart Foundation, Intellectual property report, January 2016
⁴ Academy of Medical Sciences, Starter Grants for Clinical Lecturers: Research outputs and impact, 2016
BHF research funding
The BHF’s income, derived from various sources including legacies, fundraising, retail and investment, totalled £156.6m in 2015-16, of which £133.5m was spent on charitable activities. £102.6m (77%) was spent on research (audited figure) and £30.8m (23%) was spent on prevention, survival and support activities.

The BHF is the single largest non-commercial funder of cardiovascular research in the UK, as reported in the Health Research Analysis 2014, which remains the most comprehensive recent analysis of UK-wide public and charity funded health research. The analysis highlighted the mixed economy of charity and government funding for health research in the UK. A breakdown of the annualised spend of 64 UK government and charitable research funders in 2014 showed that BHF funded more than half of all academic cardiovascular research conducted in universities and hospitals throughout the UK, contributing £71m of a total of £138.5m; Research Councils UK contributed £29m (21% of funding, with the Medical Research Council (MRC) contributing 16% of funding); government funding (other than through the Research Councils) contributed 19% (£27m), with the Department of Health (England) contributing £21m; and other charities, such as the Wellcome Trust, contributed £11.5m.

Health Research Analysis 2014 cardiovascular spend

Annual BHF funding statistics
BHF committed a total of £102.6m to 252 new grants in 2015-16 (audited figure). In the 2015-16 financial year, 610 full grant applications were assessed by peer review, with final decisions made by committees comprised of expert researchers.

The awarded research grants include (figures are rounded);

- 88 personal awards, totalling £26m
- 2 Chair awards, totalling £3m
- 125 Project Grants, totalling £26m
- 12 Programme Grants, totalling £15m
- 7 Special Project Grants, totalling £7m
- 7 Clinical Study Grants, totalling £7m
- 2 Infrastructure Grants, totalling £1m
- 1 New Horizon Grant, totalling £0.3m
- 2 Strategic Initiatives, totalling £15m
- 4 Translational Awards, totalling £1m

http://www.hrcsonline.net/pages/uk-health-research-analysis-2014
The BHF receives grant applications from research institutions across the UK. The table below lists the institutions that received the most awards or the most funding in 2015-16. The University of Oxford and the University of Cambridge both received substantial BHF funding in the 2015-16 financial year. These awards include a Strategic Initiative award of £5m towards the Oxford Institute of Developmental and Regenerative Medicine and £10m towards the Cambridge Heart and Lung Research Institute.

**Top 10 institutions - number of awards 2015-16**

<table>
<thead>
<tr>
<th>Institutions</th>
<th>Number of awards</th>
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<tbody>
<tr>
<td>Oxford, University of</td>
<td>29</td>
</tr>
<tr>
<td>Imperial College London</td>
<td>25</td>
</tr>
<tr>
<td>Cambridge, University of</td>
<td>21</td>
</tr>
<tr>
<td>King’s College London</td>
<td>20</td>
</tr>
<tr>
<td>Bristol, University of</td>
<td>18</td>
</tr>
<tr>
<td>Queen Mary, University of London</td>
<td>14</td>
</tr>
<tr>
<td>Manchester, University of</td>
<td>11</td>
</tr>
<tr>
<td>Leeds, University of</td>
<td>10</td>
</tr>
<tr>
<td>University College London</td>
<td>10</td>
</tr>
<tr>
<td>Birmingham, University of</td>
<td>9</td>
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</tbody>
</table>

**Top 10 institutions - amount awarded 2015-16**

<table>
<thead>
<tr>
<th>Institutions</th>
<th>Amount awarded</th>
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<tbody>
<tr>
<td>Oxford, University of</td>
<td>£21m</td>
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<tr>
<td>Cambridge, University of</td>
<td>£17m</td>
</tr>
<tr>
<td>Imperial College London</td>
<td>£8m</td>
</tr>
<tr>
<td>King’s College London</td>
<td>£6m</td>
</tr>
<tr>
<td>Queen Mary, University of London</td>
<td>£5m</td>
</tr>
<tr>
<td>Bristol, University of</td>
<td>£5m</td>
</tr>
<tr>
<td>University College London</td>
<td>£5m</td>
</tr>
<tr>
<td>Edinburgh, University of</td>
<td>£4m</td>
</tr>
<tr>
<td>Manchester, University of</td>
<td>£4m</td>
</tr>
<tr>
<td>Leeds, University of</td>
<td>£3m</td>
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</table>

**Amount awarded by location (2015-16)**

![Map showing percentage of funding by location](image)
BHF basic science and clinical research

Awarded applications within the 2015-16 financial year had a 77% to 23% split between the number of grants funding basic science and those funding clinical research (excluding single grant awards for multiple projects and unclassifiable grants such as infrastructure awards). Basic science grants totalled £54.8m and clinical research grants £20.8m; a breakdown using the Health Research Classification System\(^6\) can be found below.

**Partnership funding**

Co-funding initiatives allow research funders to leverage additional investment in projects or programmes from large collaborative partnerships, maximise the impact of limited resources, support larger and more ambitious programmes, and encourage the sharing of expertise across disease areas and disciplines. Details of BHF co-funding partnerships in 2015-16:

- **UKCRC Tissue Directory and Coordination Centre** (multiple funding bodies contributed including the MRC, Wellcome Trust, Cancer Research UK and the Department of Health) - A nationwide tissue directory and coordination centre.

- **MRC Clinical Research Infrastructure Initiative** (MRC with other funding bodies contributed to specific projects, including BHF, Arthritis Research UK, Wellcome Trust and Cancer Research UK) - £230m for capital and recurrent support for clinical research technologies.
  - Professor J Wild, University of Sheffield “POLARIS: Pulmonary, Lung and Respiratory Imaging” awarded £500,000 over 1 year
  - Professor S Plein, University of Leeds “Translational Hyperpolarised Magnetic Resonance” awarded £1m over 1 year

- **MRC Stratified Medicine Initiative** (MRC with other funding bodies contributed to specific projects including Arthritis Research UK and Cancer Research UK) - Disease-focused partnerships to stratify clinical practices for patient benefit.
  - Professor P Chowienczyk, King's College London “Ancestry and biological Informative Markers for stratification of Hypertension: The AIM HY study” awarded £1,100,174 over 5 years towards a total grant of £3,361,721

- **MRC Population and Systems Medicine** (joint funding with MRC and Biotechnology and Biological Sciences Research Council [BBSRC])

\(^6\) [http://www.hrcsonline.net/rac/summary](http://www.hrcsonline.net/rac/summary)
• Professor Sir N Samani, University of Leicester “Telomere length measurement in UK Biobank: advancing understanding of biological ageing and age related diseases” awarded £619,867 over 4 years towards a total grant of £2,066,224

• **British Israel Research and Academic Exchange (BIRAX)** (British Council with other funding bodies contributing to specific projects) – Supports stem cell and regenerative medicine programmes that bring together the leading scientists in Britain and Israel
  
  • Professor C Denning, University of Nottingham (and Professor L Gepstein, Israel Institute of Technology) “Gene targeted optogenetics in hPSC-cardiovascular cells for transplantation into animal models of heart dysfunction”

  • Professor P. Riley, University of Oxford (and Professor E Tzahor, Weizmann Institute of Science, Israel) “Investigating the niche-like microenvironment of the epicardium and its role in signalling to facilitate heart regeneration”

  • Professor B Péault, University of Edinburgh (and Professor J Itskovitz-Eldor, Israel Institute of Technology) “Pericytes from human pluripotent stem cells for cardiac regeneration”
Evaluating research outcomes and impacts

In the 2016 Researchfish submission period, 619 principal investigators submitted outputs from 1145 grants across 53 institutions, with a total funding value of £370,269,125. This is an overall award submission compliance rate of 90%.

Although every effort is made to ensure the Researchfish data set is of high quality, including cleaning all data before analysis, caveats remain and are explained in the report. The full breakdown of awards submitted in the 2015-16 Researchfish analysis can be found in Appendix 1, and the types of research grant funded by BHF are listed in Appendix 2.

As in the 2014-15 analysis, the outputs and impacts of BHF funded research are summarised under six headings that provide a framework for assessing the contributions of this research to academic and wider societal impacts. It is important to note that major research initiatives, such as BHF Chair awards, the BHF Research Excellence Awards, BHF Centres of Regenerative Medicine and high value co-funded awards are not included in the Researchfish dataset.
<table>
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<th>Framework for research evaluation and reporting</th>
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<tr>
<td><strong>1. Generation and dissemination of knowledge and resources</strong></td>
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<td><strong>Publications</strong></td>
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<tr>
<td><strong>Open Access compliance</strong></td>
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<tr>
<td><strong>Research resources</strong></td>
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<tr>
<td><strong>2. Further funding</strong></td>
</tr>
<tr>
<td><strong>3. Collaborations and partnerships</strong></td>
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<td></td>
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<tr>
<td><strong>4. Research translation</strong></td>
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<td></td>
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<tr>
<td><strong>5. Influence and engagement</strong></td>
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<tr>
<td><strong>6. Researchers</strong></td>
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Theme 1 Generation and dissemination of knowledge and resources

Publications
BHF commissioned Thomson Reuters (now known as Clarivate Analytics) to perform a bibliometric analysis of research articles and reviews published between 2010 and 2014 that acknowledged BHF funding. These publications were retrieved from Europe PMC by searching for “British Heart Foundation” in the ‘grant agency’ and ‘acknowledged funder’ fields (see Appendix 3). Using these data, Thomson Reuters produced metrics of paper output, impact and collaboration and benchmarked a subset of the identified BHF funded publications against cardiovascular publications authored by researchers in the UK (irrespective of funder), the rest of Europe, United States and the rest of the world (see Appendix 3 for more details about methodology).

The standard academic measure of impact is citation, which is the number of times a published paper has been referenced in other published papers. The number of citations a paper receives can vary depending on the amount of time since publication and the field of research. To account for these factors, Thomson Reuters normalises citations against the world average citations per paper for the year and journal category in which the paper was published. This is known as field-normalized citation impact (NCIF). Therefore, for a given paper, an NCIF score of 1 means the paper has been cited the average amount for a paper in that field and year.

7,049 BHF funded papers\(^7\) were included in the analysis. As shown in the figure, there has been a gradual increase in the number of publications that acknowledge BHF funding from 2010 to 2013. The slight decrease in publication volume in 2014 is expected because of the time lag in deposition of papers into the Europe PubMed repository. The NCIF of BHF funded papers is around twice the world average for most years reported.

Number of BHF funded papers and NCIF by year of publication

To identify a global comparator group against which BHF funded papers could be benchmarked, cardiovascular research papers were identified from the PubMed database. In line with

\(^7\) In the Thomson Reuters report, the term ‘paper’ refers to substantive journal articles and reviews and excludes editorials, meeting abstracts or other types of publication.
methodology used in the 2012 MRC cardiovascular bibliometric analysis, cardiovascular research papers were defined using a set of MeSH terms identified by the BHF as used frequently to index papers in the BHF dataset and relevant to cardiovascular disease (see Appendices 3 and 4 for further details). These MeSH terms were used to search the PubMed database for relevant global cardiovascular papers published between 2010 and 2014 and authored by researchers in the UK (all funders), the rest of Europe, USA and the rest of the world. A total of 343,002 global papers were retrieved. The citation count and the NCI of the retrieved papers were compared with a subset of research papers in the BHF publication portfolio identified by the same MeSH terms (see Appendices 3 and 4). 4,163 papers comprise the BHF ‘cardiovascular’ indexed dataset, which accounts for 59% of the total BHF funded papers extracted.

The analysis found that the BHF has the strongest citation impact profile of all portfolios (see the figure below). For the cohort of papers analysed, a smaller proportion of BHF associated papers were uncited compared with cardiovascular papers from the UK (all funders), the rest of Europe, USA and the rest of the world. The impact profile of BHF funded research was shifted to the right compared with the entire UK and other countries. This means that BHF funded research has the highest percentage of papers that are cited more than the world average, including the highest proportion of papers cited ≥8 times the world average.

Impact Profile of cardiovascular research papers 2010-2014

The figure below shows the NCI, number of papers and percentage of highly-cited papers acknowledging BHF funding (subset identified by ‘cardiovascular’ MeSH terms) relative to cardiovascular research papers from the UK (all funders), the rest of Europe, USA and the rest of the world. The figure shows that although BHF funded researchers published fewer papers than their comparators between 2010 and 2014, these papers have a higher academic impact measured by

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8 Internal document; Medical Research Council, Cardiovascular Bibliometric Analysis, 2012
NCIF (average NCIF = 2.01) compared with cardiovascular research papers from the whole of the UK, the rest of Europe, USA and the rest of the world (NCIF = 1.66, 1.17, 1.39 and 0.96 respectively). A larger percentage of BHF funded papers (25%) are highly cited (in the world’s top 1% of highly-cited papers, taking field and publication into account) compared with the UK, the rest of Europe, USA and the rest of the world.

**Summary of bibliometric indicators for BHF and selected comparators, 2010-2014**

The dashed line indicates the global average normalized citation impact

The number of citations a paper receives increases gradually over time and, although the Thomson Reuter’s NCIF formula accounts for date of publication, it does not account for citation trajectory. To identify recent papers that are accumulating citations rapidly (suggesting they are potentially highly influential), Thomson Reuters identified a subset of ‘hot papers’, defined as papers published in 2013 and 2014 that were cited among the top 0.1% percent world-wide between November 1st and December 31st 2015. The BHF portfolio produced eight ‘hot’ papers published in 2013 and 2014 (see Appendix 5 for details).

**Open access compliance**

The BHF supports open access publication, encouraging the widespread dissemination of BHF funded research to the broader scientific community and public. An open access publication is one that is free for anyone to read and re-use for any reasonable purpose. In accordance with BHF policy, grant holders are expected to ensure that their primary research papers or non-commissioned reviews are freely available as full text articles in Europe PubMed Central no later than 6 months after publication.
BHF provides funds to universities to support open access publication and, in 2014, became a founder member of the Charities Open Access Fund (COAF), a fund administered by the Wellcome Trust that provides financial support for gold open access publication through block grants to universities. The aim of the COAF is to ease the administrative burden of reclaiming article processing charges from individual funders, thereby promoting compliance with open access policies.

Open access compliance and full text availability of BHF funded research were assessed by searches conducted in Europe PubMed Central. The percentage of publications available as free full text has increased steadily since 2008 and 63% of articles published in 2015 were available as free full text at the end of 2016. The number of publications published under a CC-BY licence, has risen considerably in the past few years, increasing from 14% before the introduction of the COAF in 2013 to 26% in 2014 and 40% in 2015. Please note that data for 2016 may be incomplete at the time of search, therefore the drop in publications may be artificial.

**Number of free full text publications acknowledging BHF funding by year**

<table>
<thead>
<tr>
<th>Year</th>
<th>Non open access</th>
<th>Free full text available (CC-BY)</th>
<th>Percentage open access</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>551 (80)</td>
<td>725</td>
<td>80%</td>
</tr>
<tr>
<td>2011</td>
<td>686 (129)</td>
<td>761</td>
<td>80%</td>
</tr>
<tr>
<td>2012</td>
<td>760 (139)</td>
<td>813</td>
<td>80%</td>
</tr>
<tr>
<td>2013</td>
<td>856 (235)</td>
<td>846</td>
<td>80%</td>
</tr>
<tr>
<td>2014</td>
<td>954 (434)</td>
<td>752</td>
<td>80%</td>
</tr>
<tr>
<td>2015</td>
<td>1096 (679)</td>
<td>594</td>
<td>80%</td>
</tr>
<tr>
<td>2016</td>
<td>724 (548)</td>
<td>561</td>
<td>80%</td>
</tr>
</tbody>
</table>

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9 Charity Open Access Fund, [https://wellcome.ac.uk/funding/managing-grant/charity-open-access-fund](https://wellcome.ac.uk/funding/managing-grant/charity-open-access-fund)

10 Europe PMC, search performed on 13/02/2017. Search term = (GRANT_AGENCY:"British Heart Foundation") AND ((FIRST_PDATE:[2016-01-01 TO 2016-12-31])) for total and full text; and (GRANT_AGENCY:"British Heart Foundation") AND (LICENSE:"CC-BY") AND (FIRST_PDATE:[2016-01-01 TO 2016-12-31]) for publications published under a CC-BY licence.

11 CC-BY; Creative Commons Attribution licence that allows for others, including those with commercial interests, to copy, distribute and build upon the work under the condition that it is attributed
**Research resources**

Research often results in the direct or indirect production of valuable research resources, such as novel techniques, new disease models or databases. The sharing of research resources promotes collaboration and prevents unnecessary repetition in research. In the Researchfish submission 547 research resources potentially useful to other groups were reported to have been generated from 23% of BHF awards (261/1145). The types of research resources are defined in Appendix 6.

**Research resources by type**

[Pie chart showing the distribution of research resources by type: Method, assay or reagent development (31%), In vivo model of mechanisms or symptoms (24%), Data analysis technique (9%), Medical database/bioresource (9%), In vitro model of mechanisms or symptoms (7%), Non-medical database/bioresource (5%), Physiological assessment (1%), Improvements to infrastructure (1%).]

43% of the research resources created were reported to have been made available and potentially exploited by other research groups. Methods, assays or reagents were proportionally the most common output to be made available to other researchers.

**Research resources uptake by others**

[Bar chart showing the number of resources made available to other researchers, unknown or N/A, and not used outside the original research environment by type: Method, assay or reagent development (94), In vivo model of mechanisms or symptoms (90), Data analysis technique (39), Medical database/bioresource (26), Physiological assessment (16), Improvements to infrastructure (10), Non-medical database/bioresource (9), In vitro model of mechanisms or symptoms (6).]
BHF award holders reported leveraging funding from a range of different organisations across the UK, Europe and outside the European Union. As in 2014-15 the BHF was the source of the largest amount of follow-on funding to its researchers. The European Commission was the second largest follow-on funder overall. Public sector funding narrowly exceeded charitable funding as a source of follow-on grants. These results highlight the importance of BHF as a cardiovascular funder, and the mixed economy that supports cardiovascular research in the UK.

- Follow-on funding was leveraged by 281 investigators from 389 grants, which is 45% of researchers (281/619) submitting returns and 34% of total returned grants (389/1145).
- This amounts to 964 instances of further funding from 210 different funders.
- From a BHF investment of ~£370m in the returned grants, investigators reported further funding worth ~£443m, of which £307m was from a funder other than the BHF.
- The average return on investment was £1.20 per £1 of BHF investment, with the BHF providing 31% of further funding.
- The average return on investment from sources other than the BHF was £0.83 per £1 of BHF investment.
- 44 awards (11% of the 389 grants) reported leveraging more than £1m of further funding.

Further funding by value

Most follow-on funding was for amounts less than £300k. Approximately 15% of BHF awards secured £300k to £1m, and 11% of follow on funding (44/389 awards) was for amounts larger than £1m.

Further funding by value

![Graph showing percentage of awards reporting further funding by value](Image)
Further funding by organisation

BHF funded researchers leveraged grant income from 210 different organisations. The largest follow-on funder was the BHF, followed by the European Commission, the National Institute for Health Research (NIHR), the MRC and the Wellcome Trust.

Top 10 funders by value of follow-on funding

<table>
<thead>
<tr>
<th>Organisation</th>
<th>Amount of further funding (£m)</th>
<th>Percentage of total further funding (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>British Heart Foundation</td>
<td>137</td>
<td>31</td>
</tr>
<tr>
<td>European Commission</td>
<td>75</td>
<td>17</td>
</tr>
<tr>
<td>National Institute for Health Research</td>
<td>55</td>
<td>12</td>
</tr>
<tr>
<td>Medical Research Council</td>
<td>43</td>
<td>10</td>
</tr>
<tr>
<td>The Wellcome Trust</td>
<td>33</td>
<td>7</td>
</tr>
<tr>
<td>Engineering and Physical Sciences Research Council</td>
<td>29</td>
<td>6</td>
</tr>
<tr>
<td>Higher Education Funding Council for England</td>
<td>10</td>
<td>2</td>
</tr>
<tr>
<td>Biotechnology and Biological Sciences Research Council</td>
<td>7</td>
<td>2</td>
</tr>
<tr>
<td>Fondation Leducq (France)</td>
<td>7</td>
<td>2</td>
</tr>
<tr>
<td>Novo Nordisk Foundation (Denmark)</td>
<td>4</td>
<td>1</td>
</tr>
</tbody>
</table>

Total amount of further funding is £443,211,774. Values are rounded to 0dp.

Further funding by sector

Just over half of follow-on funding was secured from the public sector, mostly from the European Commission, the NIHR and the Research Councils UK, with 44% of follow-on funding secured from the non-profit sector, mostly from biomedical research charities. If one excludes follow on grants from the BHF, 76% of further funding is leveraged from the public sector, with 19% leveraged from other biomedical research charities. This indicates the inter-dependencies of the public and non-profit sectors in funding cardiovascular research in the UK. Smaller contributions of follow-on funding came from the private sector (~2%), universities/academia (~1%), Learned Societies (<1%), and hospitals (<1%).

Total amount of further funding is £443,211,774.
Non-profit sector funders

The BHF was the main source of follow-on funding from the non-profit sector, followed by the Wellcome Trust and the Leducq Foundation (see the table below).

### Non-profit sector funders contributing more than £1m of follow-on funding

<table>
<thead>
<tr>
<th>Organisation</th>
<th>Amount of follow-on funding (£m)</th>
<th>Percentage of total further funding leveraged from the non-profit sector (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>British Heart Foundation</td>
<td>137</td>
<td>71</td>
</tr>
<tr>
<td>The Wellcome Trust</td>
<td>33</td>
<td>17</td>
</tr>
<tr>
<td>Fondation Leducq (France)</td>
<td>7</td>
<td>3</td>
</tr>
<tr>
<td>Novo Nordisk Foundation (Denmark)</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>Sir Jules Thorn Charitable Trust</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Oak Foundation</td>
<td>2</td>
<td>1</td>
</tr>
</tbody>
</table>

Total amount of further funding from the non-profit sector is £193,580,939. Values rounded up to 0dp.

Public sector funders

The major public sector funder providing follow-on grants was the European Commission, followed by the NIHR and the Medical Research Council, the Engineering and Physical Sciences Research Council (EPSRC) and BBSRC. The Australian National Health and Medicine Research Council (NHMRC) contributed around £3m of further funding. BHF funded researchers gained around £2m of follow-on funding from the National Centre for the Replacement, Refinement and Reduction of Animals in Research (NC3Rs), which was the eighth largest public sector source of further funding – this amount was heavily weighted by two large awards to a single investigator.

### Public sector funders contributing more than £1m of follow-on funding

<table>
<thead>
<tr>
<th>Organisation</th>
<th>Amount of follow on funding (£m)</th>
<th>Percentage of total further funding from the public sector (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>European Commission</td>
<td>75</td>
<td>32</td>
</tr>
<tr>
<td>National Institute for Health Research</td>
<td>55</td>
<td>23</td>
</tr>
<tr>
<td>Medical Research Council</td>
<td>43</td>
<td>18</td>
</tr>
<tr>
<td>Engineering and Physical Sciences Research Council</td>
<td>29</td>
<td>12</td>
</tr>
<tr>
<td>Higher Education Funding Council for England</td>
<td>10</td>
<td>4</td>
</tr>
<tr>
<td>Biotechnology and Biological Sciences Research Council</td>
<td>7</td>
<td>3</td>
</tr>
<tr>
<td>National Health and Medical Research Council (Australia)</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>National Centre for the Replacement, Refinement and Reduction of Animals in Research</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>NHS Blood and Transplant</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Chief Scientist Office (Scotland)</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Natural Environment Research Council</td>
<td>1</td>
<td>&lt;1%</td>
</tr>
<tr>
<td>Research Foundation - Flanders</td>
<td>1</td>
<td>&lt;1%</td>
</tr>
</tbody>
</table>

Total amount of further funding from the public sector is £233,334,922. Values rounded up to 0dp.
Further funding by location

Most further funding reported was leveraged from organisations within the United Kingdom (78%, ~£345m; excluding BHF as a follow on funder: 69%, ~£209m). 20% of further funding (~£90m) was leveraged from the rest of Europe, with the European Commission contributing ~£75m (~17% of total further funding) and the Fondation Leducq contributing ~£7m (~2% of total further funding). The NHMRC (Australia) and US funders contributed around 1% of the total. Other small contributions came from funders in Asia and the Middle East.
**Theme 3 Collaborations and partnerships**

### Reported collaborations

In the Researchfish submission, BHF funded researchers recorded details of any collaborations and/or partnerships that arose from or were strengthened by work undertaken during a BHF award. The number of collaborations BHF funded researchers reported increased substantially in 2016, with 1619 collaborations in 550 awards and almost two thirds of BHF award holders reporting a collaboration (62%, 385/619). The increase in reported collaborations may be due to an increased awareness of the importance of documenting these partnerships in the context of the current political climate.

Most collaborations reported by researchers were within the UK (852 collaborations), however collaborations had global reach, with researchers reporting 385 instances of collaboration in the rest of Europe (excluding the UK) and 221 collaborations in the USA. Within Europe, the countries with the highest number of reported collaborators were Germany (87 collaborations), then the Netherlands (57 collaborations) with Italy (37 collaborations) and France (37 collaborations) joint third.

*Collaborations by country*
Most collaborations were within the academic sector (72%), suggesting that BHF funded researchers are well integrated into academic networks and recognised as valuable partners. 162 collaborations with hospitals were reported, where partnerships involved access to imaging, e.g. MRI facilities, patient information/samples or clinical research facilities. 7% of collaborations were with the private sector (see below).

**Collaborations by sector**

Collaborative authorship

Co-authorship of research papers is an indicator of successful collaboration. The Thomson Reuters bibliometric analysis revealed that 48% of all research papers acknowledging BHF funding (published between 2010 and 2014) had international co-authors, across 95 different countries, adding to evidence from the Researchfish survey that the BHF funded community has extensive and productive international research links. The map below shows the extent of international co-
authorship on BHF funded research papers. The colour scale represents the number of co-authored papers (the darker the shade of red, the greater the number of papers).

*World map of BHF funded papers with international co-authorship (2010-2014)*

The geographical profile of co-authorship is broadly aligned with that of collaborations reported in Researchfish. BHF funded researchers most frequently co-authored papers with researchers from the US. In total, 1,320 papers (~19% of BHF funded papers in the study period) included a co-author based in the US. This is almost twice the amount of papers co-authored with researchers from Germany (676 papers making up ~10% of BHF funded papers in the analysis period). The table below lists the ten non-UK countries most frequently cited as research bases for co-authors of BHF funded papers in the study period. The Netherlands, France, Italy, and Sweden follow the US and Germany in frequency.

*Top ten most frequent international locations of co-authors of BHF funded papers published from 2010-2014*

<table>
<thead>
<tr>
<th>Location of co-author</th>
<th>Number of papers with acknowledged BHF funding</th>
<th>Percentage of papers with acknowledged BHF funding (%)</th>
<th>Field normalised citation index (NCI&lt;sub&gt;F&lt;/sub&gt;)</th>
</tr>
</thead>
<tbody>
<tr>
<td>US</td>
<td>1320</td>
<td>18.73</td>
<td>3.63</td>
</tr>
<tr>
<td>Germany</td>
<td>676</td>
<td>9.59</td>
<td>4.26</td>
</tr>
<tr>
<td>Netherlands</td>
<td>598</td>
<td>8.48</td>
<td>4.37</td>
</tr>
<tr>
<td>France</td>
<td>590</td>
<td>8.37</td>
<td>3.79</td>
</tr>
<tr>
<td>Italy</td>
<td>515</td>
<td>7.31</td>
<td>4.13</td>
</tr>
<tr>
<td>Sweden</td>
<td>411</td>
<td>5.83</td>
<td>4.60</td>
</tr>
<tr>
<td>Australia</td>
<td>373</td>
<td>5.29</td>
<td>4.61</td>
</tr>
<tr>
<td>Canada</td>
<td>340</td>
<td>4.82</td>
<td>5.61</td>
</tr>
<tr>
<td>Spain</td>
<td>324</td>
<td>4.60</td>
<td>4.43</td>
</tr>
<tr>
<td>Denmark</td>
<td>317</td>
<td>4.50</td>
<td>5.23</td>
</tr>
</tbody>
</table>

*Total number of BHF funded papers analysed is 7,049.*
Collaboratively authored papers from each of the top ten countries had an NCI_F that was more than three times the world average. Although Canada is the eighth most common overseas country listed as a research base for co-authors of BHF funded papers, papers published with Canadian co-authors had the highest normalized citation impact (5.61 for the study period). Papers co-authored with Danish-based researchers yielded an NCI_F of 5.23, and those co-authored with US authors yielded an NCI_F of 3.63.

Co-funding partners
The profile of funding organisations acknowledged on publications indicates how the major biomedical research funders contribute to collectively support cardiovascular research in the UK.

4677 of 7732 (60%) publications arising from BHF funded research and published in Europe PubMed Central between 2010 and 2014 cited funding from at least one other major UK research funder. 54% of publications arising from BHF funded research cited a contribution from a UK government funding agency such as the MRC, the Department of Health and others.

<table>
<thead>
<tr>
<th>Co-funder</th>
<th>Number of co-funded papers</th>
<th>Percentage of BHF funded papers (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MRC</td>
<td>3207</td>
<td>41</td>
</tr>
<tr>
<td>Wellcome Trust</td>
<td>1614</td>
<td>21</td>
</tr>
<tr>
<td>Department of Health</td>
<td>1633</td>
<td>21</td>
</tr>
<tr>
<td>Cancer Research UK</td>
<td>808</td>
<td>10</td>
</tr>
<tr>
<td>BBSRC</td>
<td>658</td>
<td>8.5</td>
</tr>
<tr>
<td>ESRC</td>
<td>418</td>
<td>5</td>
</tr>
</tbody>
</table>

Data retrieved from Europe PMC12, BBSRC, Biotechnology and Biological Sciences Research Council; ESRC, Economic and Social Research Council; MRC, Medical Research Council.

12 [http://europepmc.org/](http://europepmc.org/) search conducted on 11/11/2016; Search terms = (GRANT_AGENCY:"British Heart Foundation") AND ((FIRST_PDATE:(2010-01-01 TO 2014-12-31)))
Theme 4 Research Translation

Overview of translational activities

A primary aim of BHF’s research strategy is to ensure that research funded by BHF (or others) translates into clinical benefit for patients. To facilitate this, the BHF launched the Translational Award scheme in Q4 2014. The aim of the scheme is to accelerate the development of early stage medicines and technologies so that they are de-risked to a point where they become attractive for development by larger investors or for further translational funding. Applications are assessed by the Translational Awards Committee, made up of commercial investors and experts in drug, device and diagnostics development.

To date, the Translational Award scheme has funded seven projects:

1. Comparing the diagnostic and prognostic performance of myosin binding protein C to troponin I and troponin T in patients presenting with chest pain; £204,522, Professor M Marber, King’s College London
2. Taking a novel compound that improves outcome in sepsis into humans; £91,768, Professor J Leiper, Medical Research Council Clinical Sciences Centre
3. Lead optimisation of novel small molecule natriuretic peptide receptor (NPR)-C agonists for the treatment of myocardial infarction; £407,222, Prof A Hobbs, Queen Mary University of London
4. A novel transcatheter valve for younger patients with aortic stenosis; £248,018, Dr G Moggridge, University of Cambridge
5. Small molecules activating Nrf2 as a therapeutic approach to prevent cardiac ischemia-reperfusion injury; £161,187, Dr W Fuller, University of Dundee
6. Thymus derived Tregs expanded in vitro as a treatment for paediatric heart transplant patients to prevent cardiac allograft vasculopathy; £230,159, Professor G Lombardi, King’s College London
7. Translating a novel CT imaging method to identify vascular inflammation and vulnerable plaques; £287,000, Professor C Antoniades, University of Oxford

In addition to Translational Awards, BHF held an educational workshop for academics interested in translating their research. Industry experts including venture capital investors, pharmaceutical senior leaders, MHRA representatives, IP lawyers and medicinal chemists gave presentations on what makes a successful translational project and what applicants need to consider when applying for a Translational Award. The workshop was also an opportunity for academics to network with industry. There is a video of the workshop’s key take-home messages on the BHF website for academics that were unable to attend.

The data below are a combination of verified information from the Researchfish survey and data from the BHF Annual IP Report. The BHF Annual IP Report was completed by Technology Transfer Offices for the period January 2015 to May 2016. There was a 66% response rate. Therefore it can be expected that the data is incomplete.
New IP
Between January 2015 and May 2016, BHF was notified of 19 patents being filed (see table below for university breakdown).

<table>
<thead>
<tr>
<th>University</th>
<th>Patents filed 2015-16</th>
</tr>
</thead>
<tbody>
<tr>
<td>King’s College London</td>
<td>5</td>
</tr>
<tr>
<td>University of Cambridge</td>
<td>5</td>
</tr>
<tr>
<td>University of Oxford</td>
<td>4</td>
</tr>
<tr>
<td>University of Bristol</td>
<td>2</td>
</tr>
<tr>
<td>University of Edinburgh</td>
<td>1</td>
</tr>
<tr>
<td>University of Sheffield</td>
<td>1</td>
</tr>
<tr>
<td>University of Birmingham</td>
<td>1</td>
</tr>
</tbody>
</table>

Examples of intellectual property acquired as a result of BHF funding

**A new material for a prosthetic heart valve**
*Dr Geoff Moggridge, Dr Joanna Stasiak, University of Cambridge*

Dr Geoff Moggridge and colleagues filed a priority patent application in February 2015 (application number PCT/GB2015/050346) following their studies to develop an improved material for artificial heart valves. Existing valves are either made of rigid, mechanical material or biological tissue, which have different advantages and disadvantages. The inorganic valves, whilst being durable, increase the risk of blood clotting. By contrast, the animal tissue valves have less risk of clotting but have a more limited lifespan. The Cambridge team has patented a heart valve made from a combination of two polymers that they hope will behave like a natural valve, but will be more durable.

BHF Grant References: NH/11/4/29059 and SP/15/5/31548

**A non-invasive method to detect vascular inflammation**
*Professor Charalambos Antoniades, University of Oxford*

Professor Charalambos Antoniades has developed a novel computerized tomography (CT)-based method that detects coronary artery inflammation by quantifying changes in the fat that surrounds the coronary arteries (perivascular adipose tissue). A patent (application number PCT/GB2015/052359) was filed in August 2015 and published in February 2016. The group has since been awarded a BHF Translational Award to develop this technology further. They will apply the non-invasive CT technique to: 1) detect unstable atherosclerotic plaques 2) quantify atherosclerosis progression, and 3) predict future cardiovascular events. These studies should open the way for commercialisation and clinical adoption.

BHF Grant Reference: PG/13/56/30383

**Spin outs**

In 2015, BHF was notified of one spin-out company formation.

**Morphogen-IX to develop treatment for pulmonary arterial hypertension**
*Professor Nick Morrell, Dr Paul Upton, Dr Wei Li, University of Cambridge*

Professor Morrell and colleagues’ research, supported by BHF programme and project grant funding, has resulted in the identification of BMP ligands that selectively target the dominant pathway implicated in pulmonary arterial hypertension (PAH) from human genetic studies. In a series of preclinical studies, the Morrell laboratory has shown that BMP9 treatment reversed established PAH in both genetic and non-genetic forms of the disease. These results demonstrate the promise of direct enhancement of endothelial BMP signalling as a new therapeutic strategy for PAH. This work led to the creation of company Morphogen-IX and £1.5m seed funding from Index Ventures (now Medicxi Ventures) and Cambridge Innovation Capital.

BHF Grant Reference: RG/13/4/30107, PG/12/54/29734, PG/11/10/28724
Revenue received

All BHF grants are subject to a revenue share agreement, negotiated in the event of commercialisation. Revenue received can be a useful indicator of translation as it highlights commercial activity from technologies i.e. where intellectual property has been developed further by an industrial partner. The following revenue received from September 2004 to December 2016 has been recorded by the Research Funds Division and is from 12 separate BHF funded grants.

<table>
<thead>
<tr>
<th>Institution</th>
<th>Sum of revenue</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oxford, University of</td>
<td>£30,574</td>
</tr>
<tr>
<td>Leicester, University of</td>
<td>£33,657</td>
</tr>
<tr>
<td>Imperial College London</td>
<td>£9,466</td>
</tr>
<tr>
<td>Cambridge, University of</td>
<td>£24,758</td>
</tr>
<tr>
<td>Bristol, University of</td>
<td>£2,130</td>
</tr>
<tr>
<td>Total revenue</td>
<td>£100,585</td>
</tr>
</tbody>
</table>

Medical products and interventions

BHF award holders were asked to record details of medical products and interventions under development, either supported by the BHF award or by other funders as a direct result of research conducted during the award. The aim of this section is to record the development of drugs, diagnostics or other technologies with potential medical uses.

After data cleaning, the report indicates that BHF funded research has led to the development of medical products or interventions in 15 awards (1.3% of total returned grants), representing 17 unique products. These products included drugs/small molecules, medical devices, cellular and gene therapies, diagnostic tests (imaging and non-imaging tools) and behavioural interventions.

The most common type of product or intervention reported in development is a diagnostic tool, followed by a medical device and then a drug/small molecule. 7 products are in preclinical development and 10 are in clinical development.

Medical product/intervention by type

Total is 17 medical products

- Diagnostic tool - imaging, 5
- Therapeutic intervention - medical device, 4
- Therapeutic intervention - drug/small molecule, 3
- Diagnostic tool - non-imaging, 2
- Preventive intervention - behavioural risk modification, 2
- Therapeutic intervention - cellular and gene therapy, 1
### Medical products/interventions by developmental stage

#### Preclinical development

<table>
<thead>
<tr>
<th>Product type</th>
<th>Number of products</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Therapeutic intervention - medical device</td>
<td></td>
<td>Prosthetic heart valves</td>
</tr>
<tr>
<td>Therapeutic intervention – drug/small molecule</td>
<td>3</td>
<td>Anticoagulant, inhibitor of angiogenesis, bone morphogenetic proteins for pulmonary arterial hypertension</td>
</tr>
<tr>
<td>Diagnostic tool - non-imaging</td>
<td>1</td>
<td>Assay to diagnose bleeding disorder</td>
</tr>
</tbody>
</table>

#### Clinical development

<table>
<thead>
<tr>
<th>Product type</th>
<th>Number of products</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diagnostic tool - imaging</td>
<td>5</td>
<td>Magnetic resonance imaging (MRI) sequence development, MRI analysis software, enhancement of CPET-MRI</td>
</tr>
<tr>
<td>Preventive intervention - behavioural risk modification</td>
<td>2</td>
<td>Behavioural intervention targeted at physical activity, smoking cessation</td>
</tr>
<tr>
<td>Diagnostic tool - non-imaging</td>
<td>1</td>
<td>Diagnostic gene panel</td>
</tr>
<tr>
<td>Therapeutic intervention - medical device</td>
<td>1</td>
<td>Infundibular reducer</td>
</tr>
<tr>
<td>Therapeutic intervention - cellular and gene therapy</td>
<td>1</td>
<td>Cell therapy to promote arteriogenesis in peripheral arterial disease</td>
</tr>
</tbody>
</table>

Most medical products in development were reported to be in early development, with two products, (a diagnostic gene panel and one imaging analysis tool to detect cardiac and hepatic iron) reported as being at the stage of wide scale clinical adoption.

**Comment**

Most grants in the Researchfish portfolio have a start date of 2009 or later and, therefore, as noted in the previous report, it is not anticipated that there will be many translational outputs in this time period from this relatively immature portfolio, most of which focuses on discovery science. The Translational Awards were not included as part of the 2015-16 submission period because of the timing of the submission period, but will be included in future collections. With the launch of the Translational Award scheme and the Foundation’s drive to increase awareness of the opportunities and mechanisms available to researchers for translational work, it is expected that the outputs in this section will increase in future years.

Some of the entries reported by researchers in their Researchfish submissions for this outcome refer to work that has either established preclinical or early clinical proof of concept for a particular therapeutic target or diagnostic assay (e.g. preclinical studies of aromatase inhibitors in pulmonary arterial disease; experimental medicine studies of apelin proteins in heart failure). These proof of concept studies, although not examples of medical product development by the researchers per se, are nevertheless essential links in the evidence chain to support further development of a medical product. As the BHF develops more sophisticated methods of tracking its research outputs over time, the broader contributions of its large research portfolio to medical product development will become more readily apparent.
Interactions with the private sector

Further funding leveraged from the private sector
Around £11m of the ~£443m (~2%) of further funding reported in the 2016 Researchfish submission was leveraged from the private sector. Of the 36 grants, 27 were for amounts less than £300k and included industry based studentships, young investigator awards and project grants. Five grants were for more than £500k, with three worth more than £1m.

Collaborations and partnerships with the private sector
57 BHF award holders recorded details of 118 collaborations or partnerships with the private sector, a small increase from 2015. The nature of the collaboration or partnership included the following in return for scientific expertise:

- Provision of a product e.g. compounds, devices, assays, samples, data, animals in both pre-clinical and clinical settings
- Technical expertise e.g. manufacturing
- Funding e.g. of trials, projects, students
- Expertise in drug development e.g. assay design, trial design, drug screening, medicinal chemistry
- Expertise in clinical trials e.g. trial design, access to data and/or samples, patient recruitment, data analysis
- Co-authorship
- Lead in commercialisation

The most common types of private sector collaborator were big pharma (31%) and biotech (including specialty pharma, platform companies and spin-outs; 22%).

Collaborations by private sector type

- Big pharma, 37
- Biotech, 26
- Medical device companies/Medtech, 20
- Laboratory suppliers, 19
- Contract Research Organisation, 9
- Consumer goods companies, 4
- Consortia, 2
- Investors, 1
Theme 5 Influence and engagement

Influence on policy or practice
BHF award holders recorded details of any significant influence on policy or practice that was realised as a result of BHF funding, including:

- Policy or practice influenced at a local, regional, national or international level
- Influence on all policy areas that affect society and the economy
- Influence on systematic reviews, clinical guidelines and policy documents (e.g. shaping guideline recommendations)
- Membership of, or participation on, an advisory committee (e.g. for a funding organisation or for a conference)
- Membership of, or participation in, a government review
- Influences on training and education development.

11% of BHF funded researchers (68 grant holders) reported 135 examples of activities that might have an influence on policy or practice. These influences on policy or practice were reported arising from 87 grants, which is ~8% of all submitted returns.

Types of policy or practice influence
Similar to reports in 2015, of the 135 influences on policy or practice, more than half involved participation on an advisory or guideline committee and around a third involved influencing the training of practitioners or researchers through the award holder’s own practice.

Policy or practice influence by type
Total number of instances is 135

Policy or practice influence by location
These influences on policy or practice were reported to have global reach with around 37% documented as affecting policy or practice across multiple continents or at an international level. 36% reported an influence on policy or practice at national level, with 6% reporting an influence on policy or practice at local level.
**Specific impact of policy or practice activity**

Most award holders reported that the impact of their policy or practice activity was unknown. Improvements in survival, morbidity or quality of life were reported for 10 instances. These included citations in a clinical guideline or participation on an advisory committee that had implications for the prevention, diagnosis or treatment of cardiovascular disease. As this is self-report, it was sometimes difficult to reconcile the specific impact stated with the type of policy/practice activity reported.

**Specific impact of influence on policy or practice**

*Total number of reported impacts is 46*

- No impacts yet, not known, 91
- Improved educational and skill level of workforce, 17
- Improvements in survival, morbidity or quality of life, 10
- Improvements in healthcare delivery (efficacy, effectiveness or access), 7
- Improvements in public service delivery (efficacy, effectiveness or access), 5
- Improved regulatory environment, 4
- Economic impacts, 2
- Effective solutions to societal problems, 1
Working together to ‘Protect Research, Save Lives’

The results of the 2015-16 Government Spending Review were announced in November 2015. The previous Government had agreed to ring fence the science budget until April 2016, but on this occasion there was concern that this protected budget would not be maintained. As part of a charity-wide initiative, our Policy Team worked closely with the BHF research community to compile a report that articulated the benefits of medical research to the nation’s health and wealth. The report stressed how collaborative funding for research (government, charity and private sector) is essential for the maintenance of a strong UK science base. BHF Professors David Newby, Costanza Emanueli and Sir Rory Collins recounted timelines of their scientific achievements, highlighting how a combination of funding sources from different sectors has been instrumental in supporting their research programmes.

As part of this campaign, 1,500 of our supporters wrote to their MPs, calling for the current science budget to be maintained. BHF Professor Andrew Newby helped to galvanise public support by featuring in an article in Heart Matters Magazine, explaining why “research funding is the lifeblood of everything we do”.

BHF fellows rose to the challenge as well, attending Party Conferences and ensuring that politicians were aware that the BHF research community regarded maintenance of the science spend as a priority and critical to its mission to save lives.
Engagement activities

47% of BHF funded researchers (289 grant holders, 423 awards) within the Researchfish submission reported participating in 1082 public engagement activities. Public engagement activities ranged from improving public understanding of scientific advances to inspiring the next generation of scientists. The dissemination of research findings to academic peers (conference attendance), although integral to the progression of research, has been excluded from the Researchfish engagement question set. Therefore for the purposes of this report, we will be looking at engagement outside of academia (but including Undergraduate and Postgraduate outreach).

Types of engagement activity

Participation in an activity, workshop or open day was the most commonly reported engagement activity (35%), involving the public (168 instances) or schools (100 instances). The next most frequently used method of engagement was a talk or presentation (outside of a conference setting, 32%), with again most audiences being the public (119 instances) or schools (71 instances).

Audience of engagement activity

Over half (59%) of all engagement activities were with the public (467) and schools (175), and included a range of activities such as interactive communications during an activity, workshop or open day (268) or more formal communications such as a talk or presentation (190).
<table>
<thead>
<tr>
<th>Story</th>
<th>Summary of the research</th>
<th>Main coverage*</th>
<th>Social media engagement* and Altmetrics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Genetic testing for inherited heart conditions</td>
<td>Dr Stuart Cook and colleagues at Imperial College London and in Singapore reported the development of a new genetic test panel that can reliably test for all the genes currently known to cause inherited heart conditions. The new test is quicker and more reliable than standard tests, allowing accurate and faster diagnosis.</td>
<td>The Guardian (print and online), The Times (print), ITV (online), The Telegraph (online), The Mirror (online), The Express (online), BBC online, BBC Radio 4 Today programme, BBC 5 Live and regional newspaper coverage</td>
<td>BHF twitter: 11,648 impressions with 35 retweets and 31 likes</td>
</tr>
<tr>
<td>Imaging critical limb ischaemia</td>
<td>A paper by BHF Intermediate Clinical Fellow Mr Bijan Modarai and colleagues at King’s College London described the development of an imaging technique, BOLD-CMR, to reliably measure the restoration of blood flow to the leg after revascularisation for critical limb ischaemia.</td>
<td>Daily Mail (print), The Telegraph (online) and other news outlets.</td>
<td>BHF Facebook post reached 51,535 people and received 240 likes, comments and shares. The video post received 394 ‘30 second’ views</td>
</tr>
<tr>
<td>Magnetic resonance imaging can identify high risk patients with coronary heart disease</td>
<td>A clinical study led by Professor John Greenwood at the University of Leeds showed that cardiac MRI is better than the more routinely used SPECT scan at predicting serious events, such as death or heart attack, in people with chest pain suspected to be angina.</td>
<td>The Daily Express (online), ITV (online) and regional newspaper coverage</td>
<td>BHF twitter: 7,676 impressions with 27 retweets and 24 likes</td>
</tr>
</tbody>
</table>

*BHF twitter/Facebook data retrieved 3 days after media activity
**Theme 6 Researchers**

**BHF personal awards**
The Research Strategy 2015-2020 reiterates the BHF’s commitment to supporting cardiovascular researchers throughout their careers and to developing the next generation of cardiovascular research leaders by nurturing research talent.

The Strategy Review expert panels highlighted the challenges of successfully transitioning from an Intermediate Fellowship (supporting early career scientists establishing themselves as group leaders) to a Senior Fellowship (which demands internationally competitive academic outputs), and of successfully pursuing a clinical academic career. The lack of retention of women in cardiovascular science was also noted as areas of concern. The panels agreed that access to mentorship and careers advice were essential to enable young researchers to progress to leadership positions.

The views expressed at the BHF Strategy Review reinforce those of a survey conducted by the MRC to explore the career choices of non-clinical biomedical researchers in the first 10 to 20 years following their MRC funded award. The MRC report concluded that more flexible funding, additional funding for early career researchers, supporting researchers at transition points (particularly from PhD to postdoctoral scientist and from post-doc to research independence/principal investigator), clearer signposting of career options, and increased opportunities for mentoring and careers advice were key enablers of a successful research career.

**Clinical academic careers survey**

To further understand the barriers and enablers of a clinical academic career, BHF participated in a cross funder survey of clinicians in research led by the MRC. The survey collected information from more than 400 clinicians who had applied to funders for clinical research training fellowships or intermediate clinical fellowships. The report found that a critical junction for clinical trainees in establishing a research career occurs in the years following the award of their PhD, when they consolidate their research skills and concurrently continue clinical training. Success in securing funding and exposure to good mentoring were noted as important enablers.

**Flexible, longer term personal awards**
Drawing from the insights from the academic surveys and in line with the recommendations of the Research Strategy Review panels, the BHF has revised its personal award schemes, increasing the duration of career development awards to allow younger researchers the time to consolidate outputs and make competitive applications for more senior awards. The Foundation has also embedded the principle of flexible working across all grant schemes to attract and retain women in

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13 Medical Research Council, Bringing Research Careers into Focus, An MRC Review of Next Destinations, March 2015
14 Medical Research Council, A Cross-Funder Review of Early-Career Clinical Academics: Enablers and Barriers to Progression, November 2015
cardiovascular science. The success rates of fellowship applications and the gender ratio of students and fellows are monitored.

Changes to personal awards

Basic science fellowships

- PhD Studentships – international students, including those without a connection to the European Economic Area, will now be eligible for BHF PhD studentships.

- Immediate Postdoctoral Basic Science Research Fellowship – the eligibility and duration of this fellowship scheme have been increased. Researchers can now apply within 2 years of the date of their PhD viva (increased from 1 year). The duration of the fellowship has been increased to 4 years (from 3 years + 1 year possible extension).

- Intermediate Basic Science Research Fellowship – the duration of the fellowship is now 5 years + 2 years possible extension (increased from 4 years + 1 year).

- Career Re-entry Research Fellowship – the eligibility and duration of this fellowship scheme have changed. Applicants can now return after a 1 year career break (previously 2 years). The duration has been increased to 4 years + 1 year possible extension (increased from 3 years + 1 year).

BHF non-clinical fellowships

Revised fellowship schemes in red

Clinical Research Fellowship

- Intermediate Clinical Research Fellowship – the duration of this fellowship has been increased to 5 years + 2 years possible extension (increased from 4 to 5 years duration).
BHF clinical fellowships

Application and award rates for studentships and fellowships
In the financial year 2015-16, the BHF directly funded 90 personal awards (from PhD to Professor). Application numbers and award rates for 2015-16 are shown below.

Application and award rates for non-clinical fellowships 2015-16

<table>
<thead>
<tr>
<th>Fellowship type</th>
<th>Awards/applications</th>
<th>Active awards at year end*</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 year PhD Studentship</td>
<td>33/62 (53%)</td>
<td>106</td>
</tr>
<tr>
<td>4 year PhD Studentship</td>
<td>9 universities, 4 students per university</td>
<td>165</td>
</tr>
<tr>
<td>Advanced Training Award</td>
<td>1/0</td>
<td>0</td>
</tr>
<tr>
<td>Immediate Postdoctoral Basic Science Fellowship</td>
<td>4/9 (44%)</td>
<td>8</td>
</tr>
<tr>
<td>Career Re-entry Fellowship</td>
<td>1/1</td>
<td>2</td>
</tr>
<tr>
<td>Intermediate Basic Science Fellowship</td>
<td>14/41 (34%)</td>
<td>47</td>
</tr>
<tr>
<td>Senior Basic Science Fellowship</td>
<td>2/3 (67%)</td>
<td>16</td>
</tr>
</tbody>
</table>

*Data retrieved March 2016

Application and award rates for clinical fellowships 2015-16

<table>
<thead>
<tr>
<th>Fellowship type</th>
<th>Awards/applications</th>
<th>Active awards at year end*</th>
</tr>
</thead>
<tbody>
<tr>
<td>MBPhD Studentship</td>
<td>1/1</td>
<td>2</td>
</tr>
<tr>
<td>Clinical Research Training Fellowship</td>
<td>20/53 (38%)</td>
<td>57</td>
</tr>
<tr>
<td>Intermediate Clinical Fellowship</td>
<td>2/9 (22%)</td>
<td>15</td>
</tr>
<tr>
<td>Senior Clinical Fellowship</td>
<td>2/4 (50%)</td>
<td>6</td>
</tr>
</tbody>
</table>

*Data retrieved March 2016
Two BHF Professors were awarded in 2015-2016:
- The BHF Chair of Cardiovascular Immunology was awarded to Professor Federica Marelli-Berg, Queen Mary University of London.
- The BHF Field Marshal Earl Alexander Chair of Cardiovascular Medicine was awarded to Professor Keith Channon, University of Oxford.

**Fellowship applications and success rate by gender (2009-10 to 2015-16)**

<table>
<thead>
<tr>
<th>Gender</th>
<th>Awarded</th>
<th>Rejected</th>
<th>Total</th>
<th>Award rate</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Intermediate Basic Science Research Fellowship</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>32</td>
<td>56</td>
<td>88</td>
<td>36%</td>
</tr>
<tr>
<td>Male</td>
<td>38</td>
<td>79</td>
<td>117</td>
<td>32%</td>
</tr>
<tr>
<td><strong>Senior Basic Science Research Fellowship</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>6</td>
<td>4</td>
<td>10</td>
<td>60%</td>
</tr>
<tr>
<td>Male</td>
<td>16</td>
<td>20</td>
<td>36</td>
<td>44%</td>
</tr>
<tr>
<td><strong>Clinical Research Training Fellowship</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>47</td>
<td>64</td>
<td>111</td>
<td>42%</td>
</tr>
<tr>
<td>Male</td>
<td>113</td>
<td>124</td>
<td>237</td>
<td>48%</td>
</tr>
<tr>
<td><strong>Intermediate Clinical Research Fellowship</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>3</td>
<td>8</td>
<td>11</td>
<td>27%</td>
</tr>
<tr>
<td>Male</td>
<td>16</td>
<td>43</td>
<td>59</td>
<td>27%</td>
</tr>
<tr>
<td><strong>Senior Clinical Research Fellowship</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0%</td>
</tr>
<tr>
<td>Male</td>
<td>8</td>
<td>15</td>
<td>23</td>
<td>35%</td>
</tr>
</tbody>
</table>

**Number and gender of non-clinical PhD students and fellows***

*Data retrieved March 2016. Gender is not documented for three PhD students.*

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* PhD Studentship | 4 year PhD Studentship | Immediate PostDoctoral Basic Science Research Fellowship | Career Re-entry Research Fellowship | Intermediate Basic Science Research Fellowship | Senior Basic Science Research Fellowship
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**Female** | 58 | 107 | 58 | 22 | 25 | 4
**Male** | 45 | 58 | 2 | 1 | 12 | 1

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*Data retrieved March 2016. Gender is not documented for three PhD students.*
Supporting BHF fellows

**BHF Fellows Meeting**

Our bi-annual Fellows Meeting is an opportunity for fellows and final year PhD students to meet and engage with BHF staff and feel part of the BHF family. In September 2015, 90 delegates gathered at Queens’ College Cambridge to hear career talks by BHF Professor Mark Kearney and selected fellows; get advice on how to write a successful fellowship application; and gain insights into translational research and publishing in high quality journals. There were networking opportunities and poster presentations. On the second day of the meeting, fellows and students became ‘judge and jury’ as members of a mock Project Grants Committee. The next Fellows Meeting will be held on the 25th and 26th September 2017.

**BHF 4 year PhD meeting**

Every year, our 4-year PhD students organise an annual meeting to share their research and experiences in the BHF 4-year PhD programme. The 2016 meeting took place in Glasgow, with 134 delegates, including 117 PhD students. They heard talks from students, principal investigators and BHF staff. The 2017 meeting will be hosted by King’s College London.

**Observing at a BHF Project Grants Committee**

All BHF Immediate and Intermediate Fellows are invited to attend a meeting of the BHF Project Grants Committee during the latter part of their fellowship. This is an opportunity for them to learn more about how we award our grants, find out the panel’s criteria for a successful grant application and meet the BHF Research Funds team.

Anna Zampetaki, BHF Intermediate Fellow at King’s College London, blogged about her experience as an observer, noting that:

“Innovative ideas and ambition were also favourably received, while derivative applications that adapted similar approaches to previously published work were less convincingly met.”
BHF Intermediate Clinical Fellows are eligible to register with the Academy of Medical Sciences mentoring scheme, and the BHF is currently investigating opportunities for expanding mentoring opportunities to its non-clinical fellows.

Next Destinations
The BHF recognises the importance of tracking the career progression of its funded researchers to monitor the retention of scientists in academia and the transition points at which attrition may occur. The Researchfish database is not optimal for tracking careers of individuals who are not award holders. This has been acknowledged by Researchfish and the next destination question set has been amended for the 2017 submission period. BHF is currently scoping the best methods for tracking the careers of its funded researchers, but for the purposes of this report, the data from the 2016 Researchfish submission are used.

Of the 504 support staff reported as leaving a BHF funded grant, 47% (236) were described as postdoctoral researchers, 26% (132) were described as research students, 13% (65) were described as researchers with no PhD, 8% (39) were clinical research training fellows and 5% (23) were described as research fellows. The remaining roles were described as management/administration (6) or as research project leaders (3). This includes people leaving BHF awards that have closed, people leaving for opportunities elsewhere or retiring, and people leaving fixed-term positions such as studentships.

Of staff leaving a BHF funded grant, 67% (338) were reported as continuing in a research active occupation. 12% (59) entered a healthcare related role (possibly returning to clinical practice), 6% (28) became full-time lecturers or teachers and 4% (21) went into management/administration roles.

Roles held by staff leaving grant

- Postdoctoral researcher 47%
- Research student 26%
- Researcher (no PhD) 13%
- Clinical research training fellow 8%
- Research fellow 1%
- Management/admin 1%
- Research project leader (with budgetary responsibility) 1%
Next destinations for staff leaving grant

78 clinical research training fellowships ended within the period covered by the 2016 Researchfish submission period. The next destination of 39 clinical research training fellows (50%) was reported by their supervisors, meaning this section is under-reported by 50%.

69% of clinical fellows (27) returned to a role in healthcare presumably to continue clinical training, 13% (5) were awarded personal fellowships and 10% (4) became postdoctoral researchers. One fellow was reported to be a research project leader. 35 of 39 fellows were reported to have been awarded either a PhD or MD.
**Next destination of clinical research training fellows**

![Chart showing the distribution of next destinations of clinical research training fellows]

- Health care/medical staff: 3%
- Research fellow (individual fellowship): 3%
- Postdoctoral researcher: 10%
- Other research occupation: 13%
- Lecturing or teaching: 3%
- Research project leader (with budgetary responsibility): 69%

**Next destination of PhD students**

111 non-clinical PhD studentships ended within the period covered by the 2016 Researchfish submission period. 69 primary supervisors of non-clinical PhD students reported the next destination of the student on the grant, representing 62% of students. Supervisors reported that 59% of PhD graduates (41) were working as postdoctoral researchers, 19% (13) held another research related occupation and 7% (5) were working in healthcare. 59 of 69 students were reported to have been awarded their PhD.

![Chart showing the distribution of next destinations of PhD students]

- Postdoctoral researcher: 14%
- Other research active occupation: 7%
- Healthcare/medical staff: 19%
- Other (non-research): 59%

**Next destination of postdoctoral researchers**

Principal investigators reported the next destination for 236 postdoctoral researchers working as support staff on a BHF grant. 75% (176) of postdoctoral researchers leaving their post remained in a research active occupation, 9% (22) took up a lecturing or teaching position and 6% (12) entered either healthcare or management roles. Of the 176 staff continuing in research, 75% (132) took up another postdoctoral position, 6% (14) were described as a research project leader and 6% (14) were awarded a personal fellowship. The occupation of 12% (28) of postdoctoral researchers was unknown.
Next destination of postdoctoral researchers

Next destination by sector
Overall, 60% of staff leaving any BHF grant remained in the academic (university based), 15% moved into the healthcare sector and 11% moved into the private sector.

Mapping careers
The MRC, BHF and other funders collaborated to create an Interactive Career Framework, an interactive map hosted on the MRC website signposting the funding schemes available to biomedical researchers from different funders at all stages of their career. The Framework will highlight funding opportunities for researchers at all levels.
Supporting the research careers of talented clinicians

The BHF is part of a consortium of funders administered by the Academy of Medical Sciences (AMS) that provide Starter Grants for Clinical Lecturers, offering up to £30k per award for research consumables. The grants provide Clinical Lecturers with support to gather data to strengthen applications for more substantive fellowships. Since 2011, the BHF has provided funding to a total of £990k, and has supported 40 Clinical Lecturers pursuing cardiovascular research (a total investment by the consortium of £1.1m).

The Researchfish report circulated by the AMS provides a snapshot of the outputs of the BHF Starter Grant Awardees collected in the Academy’s 2016 submission period. 29 of the 40 BHF supported awardees were included in the analysis.

One awardee, Dr Rachel Clough, based at King’s College London, spoke about her work developing non-invasive methods to help evaluate aortic dissection, where a tear in the lining of the aorta expands to create a false passage in the aortic wall. Rachel’s research analyses blood flow and pressure within this false passage in patients and how these measurements relate to progression of the condition. The Starter Grant allowed her to perform this research and access mentoring and career development activities. She has leveraged funding to develop the project further, including the award of a prestigious fellowship from the Conseil National des Universités that funded an out of programme training year in Lille, France.

Awards and recognition

In the 2016 Researchfish collection:

- 312 researchers (50% of all award holders submitting returns) reported receiving 1767 awards, prizes or other recognition.
- The most common type of award or recognition was being invited to speak at a conference (49%) followed by receiving a research prize (14%) or a prize for presenting a poster or an abstract at a conference (9%).
- Three BHF funded researchers reported receiving an NIHR Senior Investigator Award and one researcher reported receiving an NIHR Clinical Excellence Award.
- Professor Mandy MacLean (University of Glasgow) was awarded an MBE for services to public engagement and science (2010) and Professor John Pepper (Imperial College London) was awarded an OBE for services to heart and lung surgery (2015).
Orders of merit

- **Professor John Pepper** received an OBE for services to heart and lung surgery in 2015.

Fellows of the Academy of Medical Sciences

The following researchers who have received BHF funding were elected new Fellows of the Academy of Medical Sciences in 2015:

- **Professor Philip Bath**
- **BHF Professor Kinya Otsu**
- **Professor Naveed Sattar**
- **Professor Liam Smeeth**
- **Professor Tim Spector**

Fellows of the Royal Society

- **BHF Professor Sir Rory Collins** was elected as a Fellow of the Royal Society in 2015.

Awards and medals

Researchers who have received BHF funding reported receiving the following prestigious awards:

- **BHF Professor Barbara Casadei** was awarded The Thomas Lewis Lecture and Silver Medal of the British Cardiovascular Society in 2014, and was elected President of the European Society of Cardiology for the period 2018-2020.
- **BHF Professor David Newby** was awarded the Sir Jules Thorn Award for Biomedical Research in 2015.
- **Professor Colin Berry** was awarded the Bernard and Joan Marshal Research Excellence Prize from the British Society for Cardiovascular Research in 2014.
- **BHF Professor Martin Bennett** was awarded the William Harvey Outstanding Scientist Research Prize in 2014.
Awards won by early career BHF funded researchers

- *Dr Marc Dweck* received the Michael Davies Early Career Award from the British Cardiovascular Society in 2016.
- *Dr Alexander Liu* was awarded a Young Author Achievement Award by the American College of Cardiology in 2015.
- *Dr Adam Lewandowski* was awarded the Young Research Workers Prize from the British Cardiovascular Society in 2015.
Concluding remarks

The 2015-16 Research Evaluation report reveals that BHF funded research is academically outstanding and internationally highly competitive. BHF funded papers have the strongest citation impact profile compared with cardiovascular papers authored by UK researchers (as a whole), European, US and global counterparts, and the BHF publications portfolio has the highest proportion of papers cited more than eight times the world average, providing compelling evidence for the quality and influence of the Foundation’s research.

BHF funded researchers are highly collaborative, with extensive and productive international links. Publications with international co-authors were especially highly cited, demonstrating the added benefits of collective and cross-border intellectual endeavours. The international reach of the BHF’s research community extends to sources of competitive grant income. In the Researchfish report, the European Commission was noted as the largest external source of follow-on grant income for BHF award holders, making up around a quarter of total external further funding. This is a higher proportion of follow on funding than that reported leveraged from the NIHR or the MRC. The ability to compete successfully for non UK funding sources adds to evidence indicating the high standing of BHF funded researchers in the international context and their integration into the broader global scientific community. The contribution of European funding to UK cardiovascular research, and the location of many key international research partners in European countries revealed by the bibliometric analysis, is noteworthy given the UK’s evolving relationship with Europe post 2016.

Pleasingly, the impact of BHF funded researchers extends well beyond producing high quality academic publications. Grant holders participate in a range of influencing and engagement activities, are internationally visible – managing successful collaborations, as members of editorial boards and invited speakers at conferences – and are regularly the recipients of awards and other tokens of esteem.

There are caveats associated with the information gathered from the Researchfish submission. As with any survey using self-report, data are often incomplete and can be difficult to interpret. There are ongoing efforts to refine the Researchfish survey to maximise the amount of information obtained and to simplify the reporting process to maintain compliance. Notwithstanding these efforts, the constraints of survey based data collections remain.

The use of bibliometric analysis to assess academic impact also has its limitations. The identification of an appropriate comparator group for specialty publications means that only a subset of the BHF publications portfolio could be included in the comparative analysis. The impact profile of the entire BHF dataset has a similar profile to the subset extracted using MeSH terms (see Appendix 4), giving reassurance that the analysis reflects the academic impact of papers across the spectrum of the BHF’s research portfolio.

The Research Excellence Framework 2014 (REF 2014) demonstrated the effectiveness of using case study evidence to articulate the impact of research, and provides a rationale for broadening research evaluation to include a more qualitative approach, with traditional academic performance indicators backed up by narratives of impact. In the context of these observations, the BHF will be reviewing its approach to evaluating and articulating research impact in the future.

The BHF’s ‘Strategy to 2020’ places research at the core of its mission to reduce mortality and morbidity from cardiovascular disease. BHF will continue its commitment to accurately evaluate the outputs and impacts of its funded research, an undertaking central to the success of the fight against cardiovascular disease.
Appendix 1 BHF 2016 Researchfish submission period

The third BHF Researchfish submission period took place from 1st February 2016 to 24th March 2016. Information was requested on 1269 grants awarded to 716 principal investigators at 54 institutions.

619 principal investigators submitted outputs from 1145 grants across 53 institutions with a total funding value of £370,269,125. This is an overall award submission compliance rate of 90%.

BHF Chairs, Centres of Research Excellence, Centres of Regenerative Medicine, Infrastructure Grants, Strategic Initiatives, 4 year PhD studentships and joint awards administered by other funders are not included in the submission.

Over half of the funding reported in the 2016 submission period was awarded to principal investigators at five research institutions: University of Oxford, King’s College London, University of Cambridge, Imperial College London and University College London.

Grant types in 2016 Researchfish submission

Of the 1145 submissions, 568 (50%) were Project Grants, 399 (35%) were Fellowships, 120 (10%) were Programme Grants, 39 (3%) were Special Project Grants, 14 (1%) were New Horizons Grants, and 5 were Clinical Study Grants (see Appendix 2 for definition of grant types).

Table of grant types in 2014 Researchfish submission

<table>
<thead>
<tr>
<th>Grant type</th>
<th>Number of grants</th>
<th>Percentage of total (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fellowship</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PhD studentships*</td>
<td>282</td>
<td>25</td>
</tr>
<tr>
<td>Postdoctoral fellowships†</td>
<td>79</td>
<td>7</td>
</tr>
<tr>
<td>Senior fellowships‡</td>
<td>31</td>
<td>3</td>
</tr>
<tr>
<td>Other fellowships&quot;</td>
<td>7</td>
<td>1</td>
</tr>
<tr>
<td>Programme Grants</td>
<td>120</td>
<td></td>
</tr>
<tr>
<td>Project Grants</td>
<td>568</td>
<td>51</td>
</tr>
<tr>
<td>New Horizons Grant</td>
<td>14</td>
<td>1</td>
</tr>
<tr>
<td>Total project grants</td>
<td>582</td>
<td></td>
</tr>
<tr>
<td>Programme grant</td>
<td>Programme Grant</td>
<td>120</td>
</tr>
<tr>
<td>-----------------------</td>
<td>----------------</td>
<td>-----</td>
</tr>
<tr>
<td>Special Project Grant</td>
<td>39</td>
<td>3</td>
</tr>
<tr>
<td>Clinical study</td>
<td>5</td>
<td>&lt;1%</td>
</tr>
<tr>
<td><strong>Total programme grants</strong></td>
<td>164</td>
<td>14</td>
</tr>
</tbody>
</table>

*PhD studentships include 3 and 4 year non-clinical PhD studentships, MBPhD studentships and Clinical Research Training Fellowships; †Postdoctoral fellowships include Advanced Training Awards, Immediate Postdoctoral Basic Science Research Fellowships, Intermediate Basic Science Research Fellowships, Intermediate Clinical Research Fellowship and Career Re-entry Fellowships; ‡Senior fellowships include Senior Basic Science Research Fellowship and Senior Clinical Research Fellowships; "Other fellowships include Travel Fellowships and a Principal Scientist Fellowship."
Appendix 2 BHF grant types

**Project Grant:** a grant for a research project lasting up to 3 years and costing less than £300,000

**Special Project Grant:** a grant for a research project costing more than £300,000 or lasting longer than 3 years (not a clinical study)

**Programme Grant:** a grant for a programme of work on a five year rolling basis

**Clinical Study Grant:** a grant to fund a clinical trial or other hypothesis led clinical study costing more than £300,000 or lasting longer than 3 years

**New Horizons Grant:** a grant to encourage participation in cardiovascular research by scientists from outside traditional cardiovascular biology

**Fellowship Awards:**

**Non-clinical fellowships**

- *Non-clinical PhD Studentship:* to provide a foundation training in research for basic science graduates
- *Advanced Training Award:* to allow researchers to enter cardiovascular science from a different field or to re-train and gain additional expertise in a different field within cardiovascular science
- *Immediate Postdoctoral Basic Science Research Fellowship:* for the most promising newly qualified postdoctoral researchers to make an early start in developing their independent cardiovascular research careers
- *Intermediate Basic Science Research Fellowship:* to fund talented individuals with the potential to become research leaders
- *Career Re-entry Research Fellowship:* to provide an opportunity to re-establish a career in cardiovascular science after a break from the laboratory
- *Senior Basic Science Research Fellowship:* to fund outstanding individuals who are expected to reach Readership or Chair level within 5 years

**Clinical fellowships**

- *Clinical Research Training Fellowship:* to provide training in research after Foundation Year two and before consultant status
- *Intermediate Clinical Research Fellowship:* to fund individuals with the potential to become leaders in academic medical research
- *Senior Clinical Research Fellowship:* to fund outstanding individuals who are expected to reach Readership or Chair level within 10 years
- *Principal Scientist:* to fund outstanding investigators with an exceptional track record. The scheme is no longer active and has been subsumed into the Senior Basic Science Research Fellowship

See ‘What we fund’ ([https://www.bhf.org.uk/research/information-for-researchers/what-we-fund](https://www.bhf.org.uk/research/information-for-researchers/what-we-fund)) for further details.
Appendix 3 Bibliometric analysis methodology

Compilation of the datasets for bibliometric analysis
The datasets for the Thomson Reuters bibliometric analysis were collected using the Web of Science Core Collection and included the following citation indexes: Science Citation Index-Expanded, Social Sciences Citation Index, and Arts & Humanities Citation Index.

The analysis included publications from January 2010 to December 2014 and included citation counts to the end of 2015.

Overall BHF dataset:
To construct the overall BHF dataset, BHF provided Clarivate Analytics, then Thomson Reuters, with a list of BHF funded publications extracted from Europe PubMed Central. A proprietary algorithm was used to match these publications to records indexed in the Web of Science database. Publications defined as ‘papers’ – research articles and reviews were included in the analysis. Below is a flowchart describing the overall process to extract relevant BHF publications from the Web of Science database.

15 [http://europepmc.org/](http://europepmc.org/) search conducted on 11/04/2016; Search term (all papers added) = (GRANT_AGENCY:"British Heart Foundation") AND (PUB_TYPE:"Journal Article" OR PUB_TYPE:"article-commentary" OR PUB_TYPE:"research-article" OR PUB_TYPE:"protocol" OR PUB_TYPE:"rapid-communication" OR PUB_TYPE:"product-review" OR PUB_TYPE:"Research-article") AND (FIRST_PDATE:(2010-01-01 TO 2014-12-31)); Search term (all papers added, 10 selected at random to confirm BHF acknowledgement) = (ACK_FUND:"British Heart Foundation") AND (PUB_TYPE:"Journal Article" OR PUB_TYPE:"article-commentary" OR PUB_TYPE:"research-article" OR PUB_TYPE:"protocol" OR PUB_TYPE:"rapid-communication" OR PUB_TYPE:"product-review" OR PUB_TYPE:"Research-article") AND (FIRST_PDATE:(2010-01-01 TO 2014-12-31)) NOT (GRANT_AGENCY:"British Heart Foundation"); Search term (BHF funding manually confirmed, 45 papers identified) = "British Heart Foundation" AND (PUB_TYPE:"Journal Article" OR PUB_TYPE:"article-commentary" OR PUB_TYPE:"research-article" OR PUB_TYPE:"protocol" OR PUB_TYPE:"rapid-communication" OR PUB_TYPE:"product-review" OR PUB_TYPE:"Research-article") AND (FIRST_PDATE:(2010-01-01 TO 2014-12-31)) NOT (GRANT_AGENCY:"British Heart Foundation");
BHF cardiovascular dataset:
To compare its research portfolio with UK and global cardiovascular research papers, cardiovascular research papers had to be identified from the PubMed database. To identify publications as ‘cardiovascular research’, the BHF team identified 159 MeSH terms that were relevant to cardiovascular research and that were used frequently to index the BHF funded publications retrieved from PubMed Central. These included MeSH terms used in a previous bibliometric analysis of cardiovascular research commissioned by the Medical Research Council in 2012\(^\text{16}\). The MeSH terms are listed in Appendix 4.

The MeSH terms were used to extract a subset of papers from the overall BHF dataset provided to Thomson Reuters for the analysis. A total of 4,163 papers comprise the BHF ‘cardiovascular’ indexed dataset, which accounts for 59% of the total BHF dataset. An impact profile of the subset of papers indexed by these terms is almost identical to that of the entire BHF funded portfolio, indicating that the subset accurately represents BHF papers and can be used as a proxy of the complete dataset.

Global cardiovascular dataset:
A global cardiovascular publications dataset was produced using the list of 159 cardiovascular MeSH terms selected by BHF. These MeSH terms were used to search related global publications in PubMed and then the outputs of this search were matched to the Web of Science using a proprietary algorithm. 343,002 global papers were extracted to produce the global cardiovascular dataset. This dataset was further classified into four groups: UK, the rest of Europe, US and the rest of the world.

Geographical origin of the research article (e.g. UK publication) was determined by the location of the authors’ addresses; for example, where one middle author’s address was within the UK and the first, last and remaining middle authors were based in France, the research article was counted as within the UK and rest of Europe for benchmarking purposes. Therefore, a single paper can be assigned to multiple groups.

\(^{16}\) Internal document; Medical Research Council, Cardiovascular Bibliometric Analysis, 2012
Appendix 4 BHF selected cardiovascular MeSH terms

Acute Coronary Syndrome
Angina Pectoris
Angioplasty, Balloon, Coronary
Angiotensin-Converting Enzyme Inhibitors
Anti-Arrhythmia Agents
Anticholesteremic Agents
Anticoagulants
Antihypertensive Agents
Aorta
Aorta, Abdominal
Aorta, Thoracic
Aortic Aneurysm
Aortic Aneurysm, Abdominal
Aortic Diseases
Aortic Valve
Aortic Valve Stenosis
Arrhythmias, Cardiac
Arrhythmogenic Right Ventricular Dysplasia
Arterial Pressure
Arteries
Arterioles
Atherosclerosis
Atrial Fibrillation
Atrioventricular Node
Baroreflex
Blood Coagulation
Blood Platelets
Blood Pressure
Blood Pressure Determination
Blood Pressure Monitoring, Ambulatory
Brachial Artery
Brain Ischemia
Brugada Syndrome
Cardiac Catheterization
Cardiac Output
Cardiac Pacing, Artificial
Cardiac Resynchronization Therapy
Cardiac Surgical Procedures
Cardiology
Cardiomegaly
Cardiomyopathies
Cardiomyopathy, Dilated
Cardiomyopathy, Hypertrophic
Cardiopulmonary Bypass
Cardiovascular Agents
Cardiovascular Diseases
Cardiovascular Physiological Phenomena
Cardiovascular System
Carotid Arteries
Carotid Artery Diseases
Carotid Artery, Common
Carotid Intima-Media Thickness

Carotid Stenosis
Cerebral Hemorrhage
Cerebrovascular Circulation
Cholesterol
Cholesterol, HDL
Cholesterol, LDL
Coronary Angiography
Coronary Artery Bypass
Coronary Artery Disease
Coronary Circulation
Coronary Disease
Coronary Restenosis
Coronary Stenosis
Coronary Thrombosis
Coronary Vessels
Death, Sudden, Cardiac
Diabetic Angiopathies
Diagnostic Techniques, Cardiovascular
Diastole
Echocardiography
Echocardiography, Doppler
Edema, Cardiac
Electrocardiography
Electrophysiologic Techniques, Cardiac
Endothelial Cells
Endothelium, Vascular
Excitation Contraction Coupling
Familial Primary Pulmonary Hypertension
Femoral Artery
Fractional Flow Reserve, Myocardial
Heart
Heart Arrest
Heart Atria
Heart Block
Heart Conduction System
Heart Defects, Congenital
Heart Diseases
Heart Failure
Heart Function Tests
Heart Injuries
Heart Rate
Heart Transplantation
Heart Valve Diseases
Heart Valve Prosthesis
Heart Valve Prosthesis Implantation
Heart Venticles
Heart-Assist Devices
Human Umbilical Vein Endothelial Cells
Hypercholesterolemia
Hyperlipidemias
Hyperlipoproteinemia Type II
Hypertension
Hypertension, Pulmonary
Hypertrophy, Left Ventricular
Hypertrophy, Right Ventricular
Hypoplastic Left Heart Syndrome
Ischemia
Ischemic Preconditioning, Myocardial
Lipoproteins, HDL
Lipoproteins, LDL
Long QT Syndrome
Mesenteric Arteries
Microcirculation
Mitochondria, Heart
Mitral Valve
Mitral Valve Insufficiency
Models, Cardiovascular
Muscle, Smooth, Vascular
Myocardial Contracture
Myocardial Infarction
Myocardial Ischemia
Myocardial Perfusion Imaging
Myocardial Reperfusion
Myocardial Reperfusion Injury
Myocardial Revascularization
Myocardial Stunning
Myocarditis
Myocardium
Myocytes, Cardiac
Neointima
Neovascularization, Physiologic
Percutaneous Coronary Intervention
Pericardium
Peripheral Arterial Disease
Plaque, Atherosclerotic
Sinoatrial Node
Stroke Volume
Systole
Tachycardia
Tachycardia, Supraventricular
Tachycardia, Ventricular
Takotsubo Cardiomyopathy
Tetralogy of Fallot
Thrombolytic Therapy
Thrombosis
Tunica Intima
Umbilical Veins
Vascular Calcification
Vascular Diseases
Vascular Resistance
Vascular Stiffness
Vasculitis
Vasoconstriction
Vasoconstrictor Agents
Vasodilation
Vasodilator Agents
Appendix 5 Bibliography of BHF funded highly cited and ‘hot’ papers

Top 20 highly cited papers acknowledging BHF funding

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<td>ALTSHULER, DM et al. (2012) An integrated map of genetic variation from 1,092 human genomes, NATURE, 491:56-65, 10.1038/nature11632</td>
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<td>ALTSHULER, D et al. (2010) A map of human genome variation from population-scale sequencing, NATURE, 467:1061-1073, 10.1038/nature09534</td>
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<td>APWEILER, R et al. (2014) Activities at the Universal Protein Resource (UniProt), NUCLEIC ACIDS RES, 42:D191-D198, 10.1093/nar/gkt1140</td>
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<td>GONIEWICZ, ML et al. (2014) Levels of selected carcinogens and toxicants in vapour from electronic cigarettes, TOB CONTROL, 23:133-139, 10.1136/tobaccocontrol-2012-050859</td>
<td>136</td>
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<td>BAIGENT, C et al. (2010) Efficacy and safety of more intensive lowering of LDL cholesterol: a meta-analysis of data from 170 000 participants in 26 randomised trials, LANCET, 376:1670-1681, 10.1016/S0140-6736(10)61350-5</td>
<td>1165</td>
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<td>APWEILER, R et al. (2012) Reorganizing the protein space at the Universal Protein Resource (UniProt), NUCLEIC ACIDS RES, 40:D71-D75, 10.1093/nar/gkr981</td>
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<td>JOSTINS, L et al. (2012) Host-microbe interactions have shaped the genetic architecture of inflammatory bowel disease, NATURE, 491:119-124, 10.1038/nature11582</td>
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<td>BUTTON, KS et al. (2013) Power failure: why small sample size undermines the reliability of neuroscience, NAT REV NEUROSCI, 14:365-376, 10.1038/nrn3475</td>
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<td>TESLOVICH, TM et al. (2010) Biological, clinical and population relevance of 95 loci for blood lipids, NATURE, 466:707-713, 10.1038/nature09270</td>
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<td>MIHAYLOVA, B et al. (2012) The effects of lowering LDL cholesterol with statin therapy in people at low risk of vascular disease: meta-analysis of individual data from 27 randomised trials, LANCET, 380:581-590, 10.1016/S0140-6736(12)60367-5</td>
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<td>DANECEK, P et al. (2011) The variant call format and VCFtools,</td>
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<td>GONIEWICZ, ML et al. (2014) Levels of selected carcinogens and toxicants in vapour from electronic cigarettes, TOB CONTROL, 23:133-139, 10.1136/tobaccocontrol-2012-050859</td>
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<td>JOSHI, NV et al. (2014) F-18-fluoride positron emission tomography for identification of ruptured and high-risk coronary atherosclerotic plaques: a prospective clinical trial, LANCET, 383:705-713, 10.1016/S0140-6736(13)01754-7</td>
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<td>CHOUCHANI, ET et al. (2014) Ischaemic accumulation of succinate controls reperfusion injury through mitochondrial ROS, NATURE, 515:431-4, 10.1038/nature13909</td>
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<td>Li, J et al. (2014) Piezo1 integration of vascular architecture with physiological force, NATURE, 515:279-U308, 10.1038/nature13701</td>
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Appendix 6 Research resource categories

**Data analysis technique** – the development or improvement of in silico projects, including statistical analyses, modelling and data manipulation, but not including any medical assessment e.g. clinical imaging or curation tools

**Improvements to research infrastructure** – improvements or development of facilities for research e.g. installation of a 3T MRI scanner for large animals

**In vitro model of mechanisms or symptoms** – the development or improvement to techniques creating in vitro models e.g. culture of cell lines, assays using ex vivo tissues, synthetic models of organs or tissues

**In vivo model of mechanisms or symptoms** – generation of animal models of disease by genetic, surgical or pharmacological applications e.g. novel mouse lines, new surgical methods to generate models of disease

**Medical database/bioresource** - contribution to/establishment of a bioinformatics database or bioresource of patient data/samples e.g. participant database, patient tissue bioresource

**Non-medical database/bioresource** – contribution to/establishment of a biological database or bioresource that does not contain patient samples/data, e.g. discovery and input of protein structures into an established database, non-human microarray databases

**Method, assay or reagent development** – any development or improvement of a protocol/assay; development of reagents directly for a protocol/assay; or reagents with potential assay development, e.g. antibodies, fluorescently tagged proteins, constructs for transfection

**Physiological assessment or outcome measure** – development of software or methods for the assessment of human data in a clinical setting e.g. novel MRI technology, cardiac modelling from angiography