Analysis and Outputs of HRB Grants that completed in 2010 and 2011

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Executive Summary

Introduction

This report presents an analysis of the 196 HRB grants (combined spend of €54.5 million) that completed in 2010 and 2011 and provides an overview of the initial outputs and outcomes arising from these grants. The purpose of the report is to provide HRB Management and the Board with strategically useful information on the impact of HRB-funded research, and by identifying significant outcomes and success stories to assist with communicating the value of HRB research to external stakeholders and the public. An important proviso in considering this report is that the analysis presented is not a complete picture of the impact of HRB-funded research, but rather a snapshot at the point of end-of-grant (EOG). In addition, it should be noted that the data presented in this report relates to grants that were awarded predominantly in the 2006-2008 period, prior to the introduction of the HRB's 2010-2014 Corporate Strategy. Hence, the data presented do not in any way measure the impact of that Strategy.

Indicator framework

The key indicators described in this report and which guided output data collection in EOG reports are based on the Buxton-Hanney payback framework for health research and are listed below for interest.

Impact Category	Key HRB Indicators
Knowledge production	• Total no. peer-reviewed publications produced • Average no. of publications per grant • No. papers per € million spend by grant type and pillar area • % papers published in journals with high impact factors • No. and type of scientific presentations by grant type
Research capacity-building	• No. and type of personnel funded • No. personnel with health professional background • No. PhDs and post-docs by grant type and pillar area • Next destination of funded personnel • No. and type of new research collaborations • No. and type of new research materials and methodologies • No. and type of research awards and recognition
Informing policy, practice and public	• % grants reporting policy/practice influences and outputs • No. and types of outputs and influences reported (eg meetings with end users, reports, guidelines, submissions produced) • No. influences by grant type and strategic pillar area • No. influences per € million spend by grant type and pillar area • No. and type of public/patient dissemination events
Health sector innovations	• % grants reporting development of health innovations • No. and types of health innovations developed (eg new drugs, interventions, diagnostics, ICT systems, care models) • Stage of development of innovations • No. innovations by main grant type and pillar area • No. innovations per € million spend by grant type and pillar area
Economic and commercial activity	• No., source and value of leveraged grants obtained • No. invention disclosures filed • No. patents filed

Impact Category	Key HRB Indicators
	• No. technologies licenced • No. spin-out companies incorporated • No. industrial collaborations established • No. commercialisation grants secured

Key output statistics for grants ending in 2010/ 2011 compared to 2008/2009 grants
(More detailed statistics broken down by grant type and research area can be found in the Appendices)

Impact Category	2010/2011 (N=196 grants)	2008/2009 (N = 204 grants)
1. Knowledge production		
No. peer-reviewed journal publications	470	526
% papers in high impact journals	28%	31%
No. scientific presentations reported	1427	1118
2. Research capacity-building		
No. health professionals trained	82	70
No. PhDs registered	72	88
No. new research collaborations formed	415	384
3. Informing policy, practice and public		
% grants reporting policy/practice outputs	24%	20%
No. policy/practice outputs and activities	100	84
% grants that disseminated to public	35%	21%
4. Health sector innovations		
% grants reporting health innovations	21%	15%
No. health innovations in development	48	32
5. Economic and commercial activity		
No. research grants leveraged	113	117
No. patents filed	11	12
No. technologies licenced	3	3
No. spin-out companies incorporated	2	2
No. industrial collaborations established	25	10

Key Findings

The analysis displayed in this report demonstrates a wide variety of outputs produced by HRB-funded research in terms of scientific output, capacity-building, health sector and economic benefits. When compared to the 2008/2009 analysis, the data shows that HRB-funded research completing in 2010/2011 led to more policy/practice outcomes and influences, produced slightly less publications per grant while maintaining an overall medium to high scientific impact, and led to an increased number of commercial collaborations.

Type of Research funded

- Grants in Biomedical research that ended in 2010 and 2011 accounted for the largest proportion of spend, at 56% (applied biomedical research accounted for 44% of spend and basic biomedical for 12% of spend). This statistic is down slightly on the corresponding

statistic for grants that ended in 2008/2009, when 64% of spend went on Biomedical research.

- The decrease in funding for biomedical research is due to more grants ending that were oriented towards the health sector and healthcare professionals, stemming from HRB initiatives introduced under *Making Knowledge Work for Health*, the first national health research strategy published by the Dept of Health in 2001.

Achievement of Grant objectives

- Just under 50% of grant-holders had achieved all of the originally proposed grant objectives by the end of grant (up slightly on the corresponding 2008/2009 figure of 57%). The most common reason cited by grant-holders for non-fulfilment of objectives was insufficient time, reflecting over-ambitious research objectives in grant proposals submitted mainly between 2006 and 2008.
- In 2009, the HRB completed the process of moving from purely national to international peer review panels. This has resulted in much greater scrutiny of the feasibility of grant proposals, to the extent that proposals can be turned down on the basis of feasibility / over-ambition alone. When combined with more robust grant monitoring procedures introduced by the HRB in 2009, it would be expected that the proportion of grants not completing all of the stated objectives will significantly decrease.

Personnel employed

- Biomedical research grants employed 83% of all post-doctoral researchers and 52% of all PhD students. The number of post-doctoral researchers employed in Population Health Sciences and Health Services Research was disproportionately low.
- Researchers with a background in the Health Professions (e.g. Medicine, Nursing, Physiotherapy) accounted for 29% of the 280 personnel employed across all grants.
- The most common next destination of HRB-funded personnel was a post-doctoral research post in a higher education setting (31% of all personnel). Of interest was that 45 personnel (16% of total) were employed in the health sector, either as a medical clinician or an allied health professional.

Peer-reviewed publications

- The 196 grants that ended in 2010/2011 produced 470 peer-reviewed publications, giving an average of 2.4 papers per grant. This is down slightly on the 2008/2009 statistic of 526 publications from 204 grants, or 2.6 papers per grant. This may correspond to the slight decrease in the number of grants in biomedical research, where peer-reviewed publications are a primary output.
- Five-year programmatic grants, on average, produced less papers per € million spend than other grant types and these papers were not published in journals with higher impact scores compared to papers produced by project or fellowship grants.
- In line with international trends, grants in Health Services Research were the least productive in producing international peer-reviewed publications as measured by average number of publications per grant and number per €1 million spend. Reasons for this include a much smaller variety of journals in which to publish relative to other disciplines such as the biomedical sciences, and a tradition of publishing in other formats (book chapters, reports, bulletins) in order to target policy-makers and other key stakeholders.

Dissemination and Collaborations

- Grant-holders reported 1427 scientific dissemination events (such as oral and poster presentations at conferences), or 7.3 per grant. This is significantly up on the 2008/2009 statistic of 1118 presentations, or 5.5 per grant.
- Grant holders reported the establishment of 415 new research collaborations during the lifetime of the HRB grant (average of 2.1 per grant). This is an increase on the 2008/2009 statistic of 384 new collaborations (average of 1.9 per grant).
- 35 per cent of grant holders disseminated their research findings to patient groups or the public – this is a significant increase on the corresponding statistic of 21% for grants that ended in 2008/2009. One surprising finding was that only 13% of grants in Population Health had disseminated to the public.

Policy and practice-oriented outputs and innovations

- 48 grant-holders (24% of total) reported a policy or practice output or influence – this is an increase on the corresponding statistic for 2008/2009 when 41 grant-holders (20% of total) reported a policy/practice output or influence.
- Grants in Clinical, Health Services Research and Population Health Sciences produced significantly more health sector outputs and influences than the Biomedical sciences (per €1m spend).
- 41 grants (21% of total) led to or directly contributed to the development of 48 health innovations – this is an increase on the 2008/2009 figure of 31 grants (15% of total) reporting the development of 32 health innovations.
- The vast majority of the 48 innovations are in the pre-clinical stages of initial development or testing and refinement. Grants in Clinical and Health services research produced more health-related innovations than the basic/applied Biomedical sciences (per €1m spend).

Intellectual property and commercial activities

- Grants that ended in 2010 and 2011 produced 11 patents, 3 licensed technologies, contributed to the establishment of 2 spin-out companies, and led to 25 academic-industry collaborations.
- In total, 36 HRB grant-holders (or 18% of all PI's) reported 54 commercial outputs - this is an increase on the 2008/2009 statistic of 27 grant-holders (or 13% of total) who reported the generation of 42 commercial outputs.
- Unsurprisingly, grants in the Biomedical sciences produced significantly more commercial opportunities than Clinical, Health Services Research and Population Health Sciences grants.

Follow-on funding leveraged

- 113 follow-on grants were leveraged by 41% of grant-holders (similar to the 2008/2009 statistic of 117 follow-on grants leveraged by 41% of grant-holders). Of the approximately €35 million that these 113 grants were collectively worth, 40% came from non-exchequer sources such as industry, charities, and international bodies.
- Only two grant-holders had secured follow-on technology development grants from Enterprise Ireland, which is a very low figure. HRB could perhaps more actively promote EI funding opportunities to researchers, particularly for those grants which have produced intellectual property or early-stage health innovations.

Conclusion

A number of strategic observations can be made from the data presented in this report:

- Grants in the biomedical and clinical sciences produced the most scientific publications and commercial opportunities such as patents and industrial collaborations;
- Grants in health services research, population health sciences and clinical research produced the most health policy and practice outcomes and research-trained the most health professional;
- Funding initiatives which were targeted at building research capacity in the health sector such as the Strategic Health Service R&D Awards and the co-funded Partnership grants (both introduced as a result of *Making Knowledge Work for Health*) produced the most health innovations and policy/ practice outputs per €1 million spend;
- Grants associated with multi-disciplinary collaborations (particularly those involving health professionals) and strategic co-funding arrangements with HSE, industry or charities (e.g. Partnership Awards, MRCG grants) tended to produce more health sector outcomes;
- The HRB/Irish Aid co-funded Global Health Research Awards, also a collaborative initiative, led to multiple outputs relevant to global health policy and achieved the highest proportion of public outreach activity.

The implication of the report findings, in terms of their relevance to the HRB's Strategic Business Plan 2010-2014 and the shift away from basic biomedical research towards greater investment in clinical research, population health sciences and health services research, is that over the coming years we may see a slight decrease in scientific 'productivity'[1] (e.g. number of peer-reviewed publications per €million spend) and commercial impact (e.g. patents, industry collaborations). However, based on the data presented, this should be offset by a concomitant increase in health sector outcomes such as development of innovations (e.g. interventions, therapies) and policy and practice outputs and influences (e.g. clinical guidelines, policy-oriented reports, advisory roles).

In summary, the number and level of healthcare innovations in development, as well as the proportion of grants that led to influences on policy and practice was encouraging and stands up very well when compared (albeit only superficially) to data on similar outcomes captured by UK funders, such as the Medical Research Council and The Wellcome Trust. Therefore, in terms of delivering on a key HRB objective of improving people's health and health care provision, HRB funded research appears to be having an increasing impact.

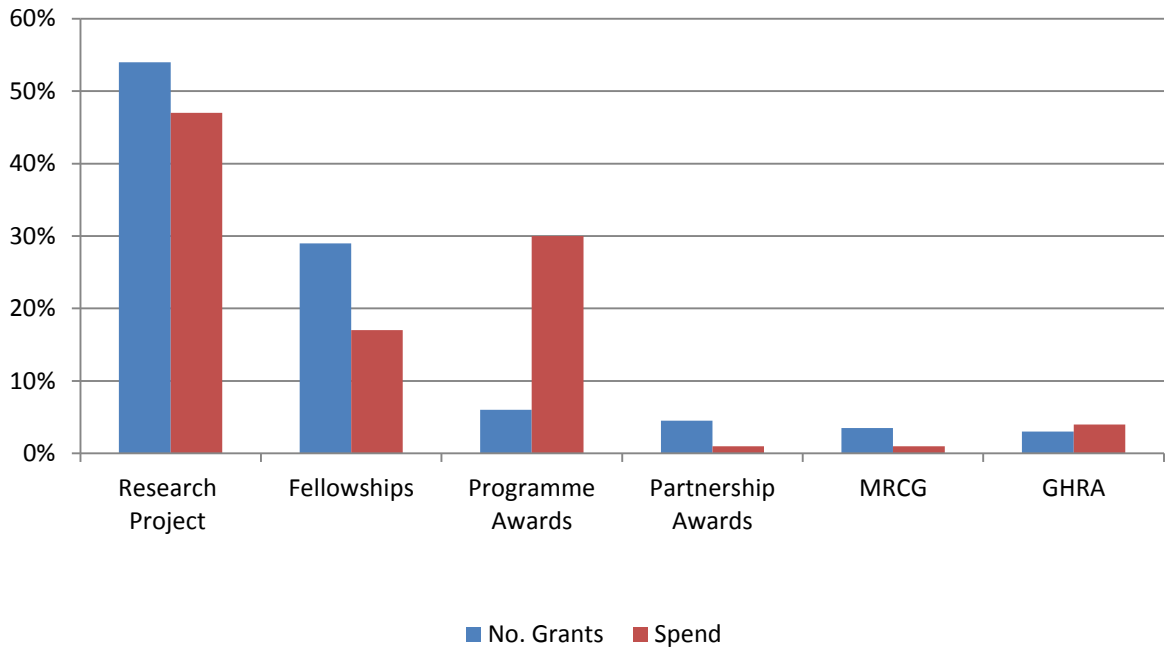
[1] It is important to note that while the data indicates that the shift away from basic biomedical research may lead to a decrease in indicators of scientific productivity, there is no reason to believe that a decrease will occur in indicators of scientific quality (e.g. field-normalised citation impact). The new HRB funding initiatives in Clinical Research, Population Health Sciences and Health services research, based on the multi-disciplinary collaborative funding model, along with the emphasis placed by international peer review panels on methodological rigour, ensures that only high-quality research is funded with the potential for both scientific and health impact.

Section 1 - Overview of completed grants

1.1 Number, type and value of grants completed

In total, 196 grants completed in 2010 and 2011. These grants had a combined value of €54.6 million. An analysis was carried out of the distribution of this funding by grant type, broad research area, specific research field or disease category, and research institution. In relation to grant type, Figure 1 shows the breakdown of the 196 grants by grant type and Figure 2 shows the breakdown of overall spend by grant type. As expected, Research Project grants (including 3 HRA's) accounted for the largest number of grants and largest proportion of grant funding, with Programmatic Grants (including the Autism Genome Project, 7 Strategic Health Service R&D Awards, 1 Clinician Scientist Award, 1 Translational Award, and 1 Programme Grant) accounting for the second largest spend. Fellowship awards accounted for almost 30 per cent of all awards and the third largest spend – this category comprised of a diverse number of fellowship schemes[2], which have since been consolidated into a small number of schemes.

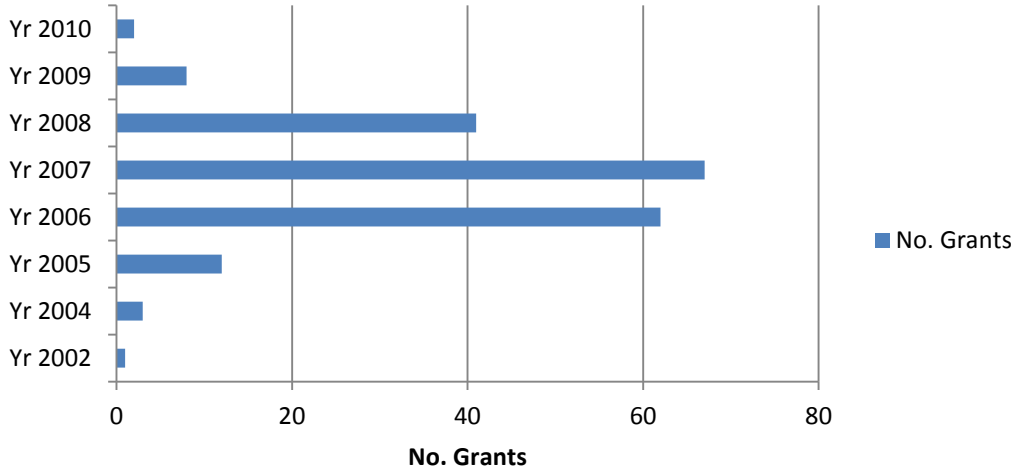
Figure 1: Number and value of grants by grant type



[2] The Fellowship category comprised of Post-Doctoral Research Fellowships (n=14), Clinical Research Training Fellowships for medical graduates (n=6), the Nursing and Midwifery Fellowships (n=5), Junior Clinician Scientist in Nursing and Midwifery (n=4), the Health Service Research Fellowships (n=7), Clinical Therapy Professional Fellowships (n=3), Cochrane Training Fellowships (n=13), the Health Professionals' Fellowships (n=3), and the Research Fellowships in Rare Diseases (n=2).

The year of award of the grants that completed in 2010/2011 is plotted in Figure 2 below and shows that the vast majority of the grants were awarded between 2006 and 2008 – in other words, the vast majority of grants were awarded before the new HRB Strategic Business Plan 2010-2014 was developed, and most of the awards were standard project grants and fellowships of 2-3 year duration. Grants that were awarded prior to 2006 were most likely to be 5-year programmes, some of which received no-cost extensions for up to one year.

Figure 2: Breakdown by Year of Award



1.2 Distribution of spend by strategic pillar area

The distribution of the €54.5 million across the five broad pillar areas is shown in Figure 3 below. For ease of analysis, each grant was allocated a **single** classification to represent the predominant focus of the award, although it is recognised that a proportion of grants span more than one area of health research (e.g. clinical / HSR). As can be seen, Applied biomedical research accounted for the largest proportion of funding (44%) while Basic biomedical research accounted for 12% of spend. Population Health Sciences and Health Services Research, when combined, accounted for almost a quarter of total spend.

When compared to grants that ended in 2008/2009 (see Figure 4), the relative distribution of spend across the four-year period is identical for Applied biomedical research, and Population Health Sciences and Health Services Research combined. However, the spend on Clinical research increased in proportionate terms from 13% for grants ending in 2008/2009 to 21% for grants ending in 2010/2011, while the spend on Basic biomedical research decreased in proportionate terms from 21% for grants ending in 2008/2009 to 12% for grants ending in 2010/2011. An analysis of the data shows that the main reason behind this change in the distribution of spend was that four programmatic grants in Clinical research, with a combined value of €5.5 million, ended in 2010/2011. These programmes comprised a single Clinician Scientist Award, two Health Service R&D Awards, and a single Translational Research Award.

Figure 3: Distribution of spend across broad pillar areas for grants ending 2010/2011

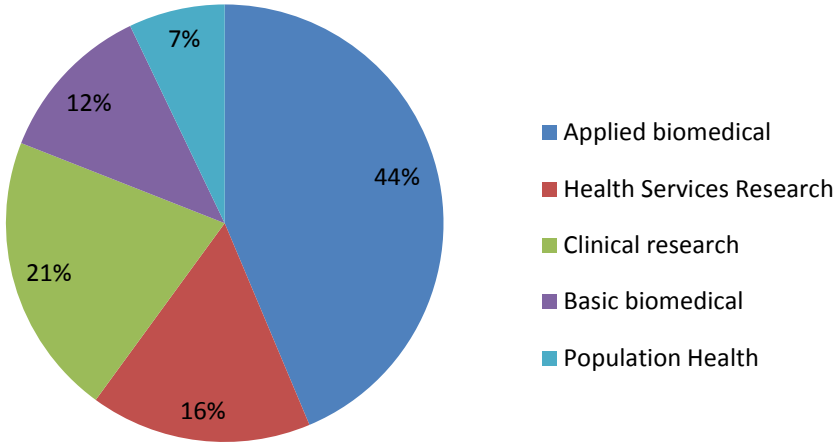
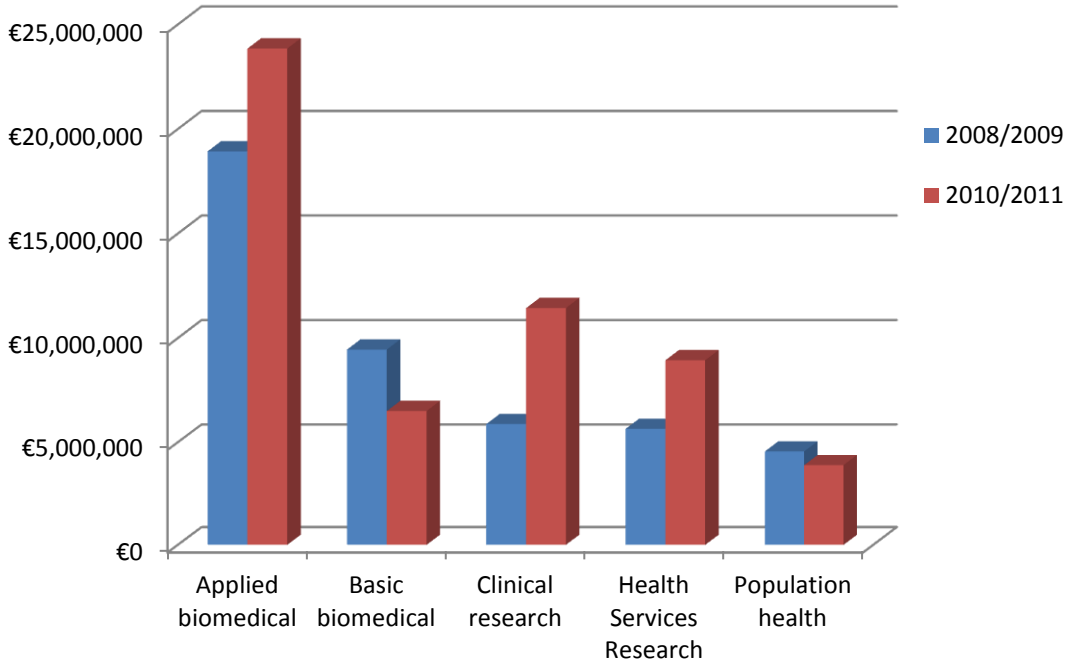


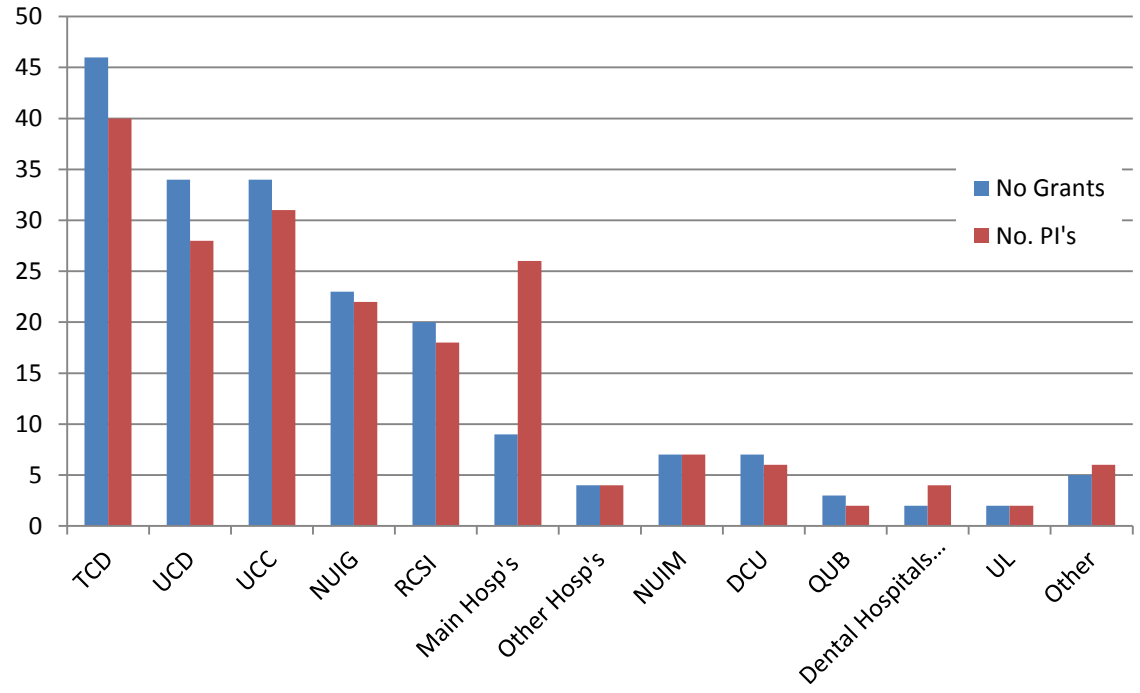
Figure 4: Comparison of spend across broad pillar areas for grants ending in 2010/2011 versus grants ending in 2008/2009



1.3 Grant host institutions

In relation to the **location and hosting** of HRB grants, Figure 5 shows the host institutions of grant recipients as well as the institutions where the research was actually conducted. Note the variances within institutions between the number of grants administered (blue key in Figure 5) versus the number of grants where the research was actually carried out within that institution (the PI's address, indicated by the red key below). This variation particularly relates to grants carried out in hospital settings but administered through the affiliated university.

Figure 5: Distribution of HRB grants across host institutions



Section 2 - Achievement of grant objectives

2.1 Proportion of grants achieving all objectives

In their original grant application, grant holders outlined specific research objectives that they sought to achieve with the HRB funding. In EOG reports, PIs were then asked to indicate the extent to which these objectives were fulfilled during the period of the grant[3]. As shown in Figure 6, just under half of grant holders indicated that they had achieved all of the original grant objectives by the time of completing the EOG report. This is slightly up on the corresponding figure for grants that completed in 2008/2009 where 57% of grants had not achieved each of the original objectives.

Figure 6: Proportion of grants with all objectives achieved

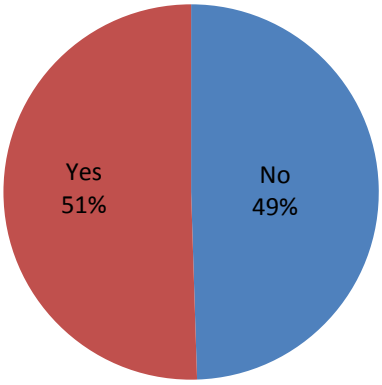
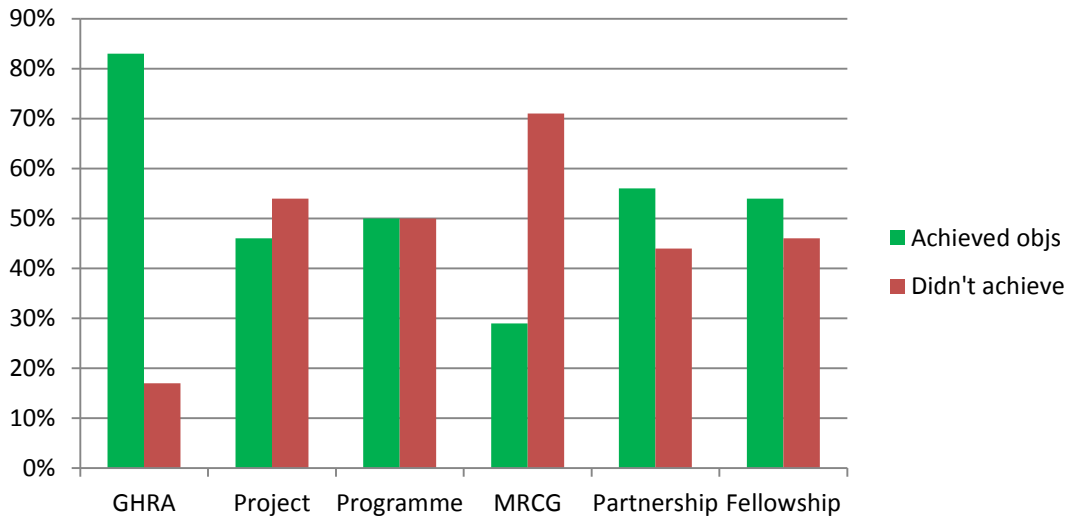


Figure 7, below, provides a breakdown of the statistic by grant type. As shown, most of the 6 Global Health Research Awards achieved the original objectives. In contrast, 5 out of 7 (or 70%) of MRCG co-funded grants did not – an analysis of the reasons provided by grant-holders (provided in Section 2.2 below) did not uncover any specific common factor behind the inability to complete all objectives in the five grants. In most cases, work on one objective (usually the final objective) was delayed or partially completed due to personnel issues or technical problems.

[3] It should be noted that grant holders are asked if they achieved all of the original grant objectives – this does not take account of the fact that PI's may have received formal approval from the HRB to change an objective(s) during the course of the grant, based on sound scientific rationale.

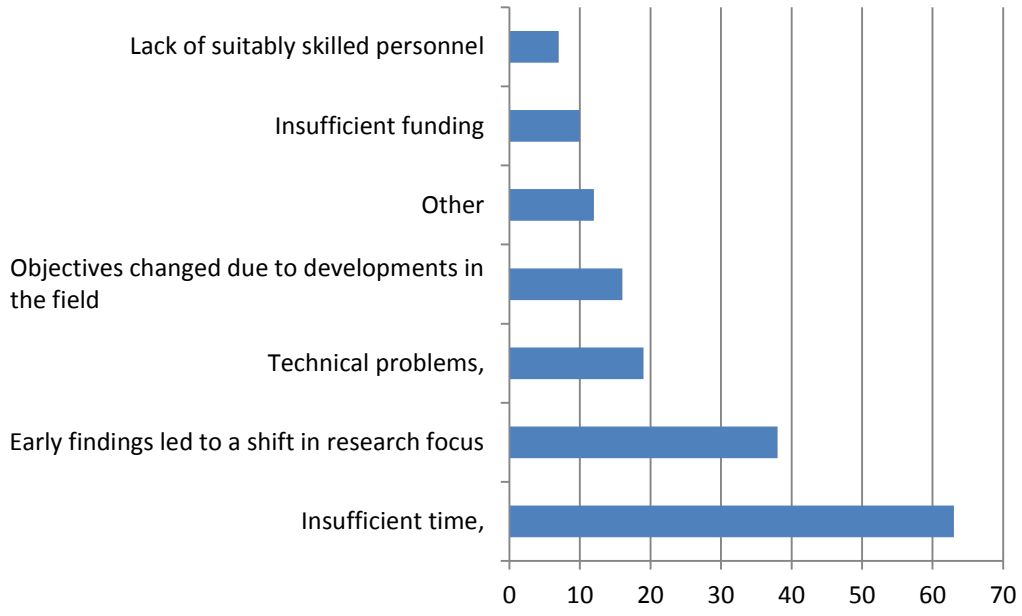
Figure 7: Achievement of grant objectives by grant type



2.2 Reasons for non-fulfilment of all original objectives

Grant holders were asked to indicate the reasons behind their inability to fulfil all of the original grant objectives. Figure 8 shows the number of times each of the given reasons was cited (note that respondents could tick more than one box). The most common reasons for non-fulfilment of grant objectives were 'Insufficient time' (63% of respondents), 'Early grant findings led to a shift in research focus' (38% of respondents), 'Technical problems or delays' (19% of respondents), or 'Developments in the research field led to a change in objectives (15% of respondents).

Figure 8: Cited reasons for non-fulfilment of original grant objectives



As shown in Figure 7 on the previous page, 5 out of 7 MRCG grant-holders did not achieve all of the original grant objectives. As can be seen in the table below that sets out the specific reasons offered by PI's for failure to achieve all of the original objectives, there is no single unique reason which might explain the MRCG statistic – insufficient time to complete the objectives was the main reason given.

Grant title	**Reasons for non-completion**	**Description of issue by PI**
MRCG/2006/9: Investigation of signalling pathways in high-grade glioma in order to predict responsiveness to tyrosine kinase inhibitors	Insufficient Time Other – Poor tissue quality	We had anticipated collecting a much higher number of tissue samples (120-130); however, we only had access to 44 samples after 26 months due to difficulties enrolling patients on this study. In the majority of cases we only received very small amounts of tissue, which would not represent the cell diversity present in these tumours and which resulted in the fact that only 26 from 37 high grade glioma cell lines grew well enough to perform the full analysis, diminishing the possibility of statistically relevant results.
MRCG/2006/2: A study of Environmental Tobacco Smoke exposure within exempted premises - Nursing Homes as defined in the Pubic Health Acts 2002&2004	Technical problems Other	The initial objective no. 4 was to determine Benzene levels in staff exposed to smoke - we were let down by the laboratory we had chosen to analyse the benzene. However in the intervening time the opportunity to monitor nicotine arose, which is more specific for second hand smoke exposure, so we replaced the benzene monitoring with nicotine monitoring. This has had no material change on the project..During the course of the study there were a number of high profile cases in the media and courts involving nursing homes and the care of patients, we observed a marked change in attitudes from Nursing Homes towards the HSE. A number of the Homes which had initially agreed to facilitate the project were not as willing to participate..this reduced the number of venues we were able to include in the study.
MRCG/2007/10: Redox regulation of apoptosis modulating survival pathways in re-current tumours	Lack of suitably skilled personnel Insufficient Time	Objective 3 was not completely achieved. The post-doctoral fellow working on this project was not as productive as I would have liked and this hindered project progression! Objectives 1 & 2 took longer to achieve than expected. This in turn had a knock on effect for the complete delivery of objective 3.
MRCG/2006/27: The Identification of Novel Immuno-modulatory Proteins from N.meningitidis serogroup B	Insufficient Time Technical problems	This project was an outstanding success in characterising the immune-modulatory effects of NarE and identifying 6 previously unidentified meningococcal immune-modulatory molecules. Objectives 1-5 were achieved in full. As a result of technical problems regarding the production of NarE by Novartis and time constraints objective 6 was not addressed. However, we fully intend to pursue this line of work and to source additional funding for this very exciting research

MRCG/2008/05: To determine how RACK1 regulates cell migration during tissue morphogenesis and tumorigenesis	Insufficient Time (grant completed early)	Unfortunately, this project was unable to continue beyond December 2010 due to the co-applicant moving from UCC to take up a permanent lectureship position at UL.

Interpretation of findings

The finding that many grant-holders did not achieve all of the original objectives can be placed in historical context and with the value of hindsight. Most of the grants analysed in this report were awarded between 2006 and 2008, at a time when:

- the HRB portfolio was still largely biomedical and exploratory in nature and therefore it could be expected that objectives / research would shift in line with early findings or developments in the field;
- grant objectives were often not explicitly stated in grant applications or were often verbose, too numerous and difficult to pinpoint (the HRB now places much emphasis in terms of requiring applicants to clearly state objectives, deliverables and milestones);
- not enough attention was given to ensuring that grant-holders contacted the HRB in real-time to request permission to shift their focus and to change objectives.

Furthermore, in 2009 the HRB completed the process of moving from purely national to international peer review panels. This has resulted in much greater scrutiny of the feasibility of grant proposals, to the extent that proposals can be turned down on the basis of feasibility / over-ambition alone. When combined with more robust grant monitoring procedures introduced by the HRB in 2009, and a practice of granting short no-cost extensions to PI's - when well justified - to complete their research, it would be expected that the proportion of grants not completing all of the stated objectives will start to decrease in the immediate future.

Section 3 - Outputs and outcomes from HRB grants

3.1 Knowledge production

3.1.1 Scientific publications

At the point of end-of-grant, the 196 grants that completed in 2010 and 2011 had produced 470 peer-reviewed scientific publications[4] from an investment of €54.5m (or an average of 2.4 papers per grant), yielding a productivity rate of 8.6 publications per million euro spent (or 1 paper for every €115,957). This compares to 11.8 publications per million spent in terms of grants that completed in 2008/2009 (or 1 paper for every €84,544). However, the average journal impact factor score (IF) for 2010/2011 publications of 4.9 was higher than that for 2008/2009 publications (IF=4.4).

A breakdown of the publication rate across the individual years from 2008-2011 is provided in Table 1. The apparent significant difference in productivity (papers per €1m spend) between 2008/2009 and 2010/2011 grants is partly due to increased filtering out by the HRB evaluation team of publications wrongly included by researchers in their end-of-grant report (see Footnote), and partly due to the proportion of programme grant funding across the years. Programme grants accounted for 30% of spend in 2010/2011, but only 18% of spend in 2008/2009. On average, programmatic grants produce less papers per €1m spend than projects. For example, €5 million was spent on the Autism Genome Project that ended in 2011 – the grant produced 16 papers (including two *Nature* papers) with an average journal impact factor score of 8. The same €5m spent on projects would have produced, on average, 45 papers with an average impact factor score of 5.1.

Table 1: Summary of publication output 2008-2011

Year	Total no. papers	Aver. papers per grant	Papers per €1m funding	Average journal impact factor score
2008	234	2.5	10.3	4.4
2009	292	2.6	13.5	4.5
2010	230	2.2	9.5	4.2
2011	240	2.6	7.9	5.7

Figure 9 below shows the distribution of all research publications by grant type. As can be seen, project grants produced over half of all publications, an expected finding given that this scheme accounted for almost half of total allocated funding. Similarly, fellowships accounted for approximately 16 per cent of funding awarded and produced a fifth of the total publications. Programmatic grants produced 22 per cent of total publications, while accounting for 30 per cent of total funding.

[4] Publications reported by grant holders in end-of-grant reports were excluded from the analysis if the date of publication preceded the grant start date, if the PI was not a listed author on the paper (with exception of programme grants), or if the subject matter of the paper was clearly unrelated to the grant objectives.

Figure 9: Breakdown of peer-reviewed publications by grant type

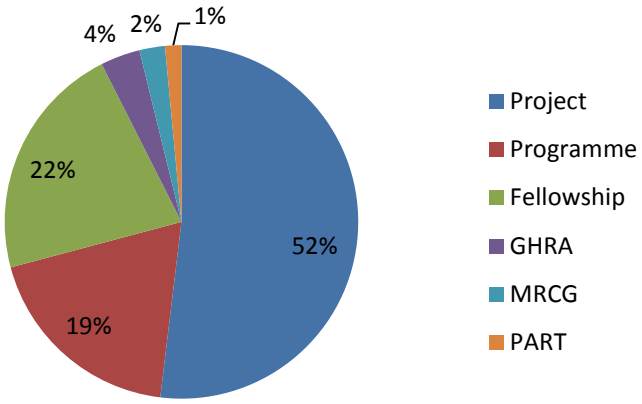
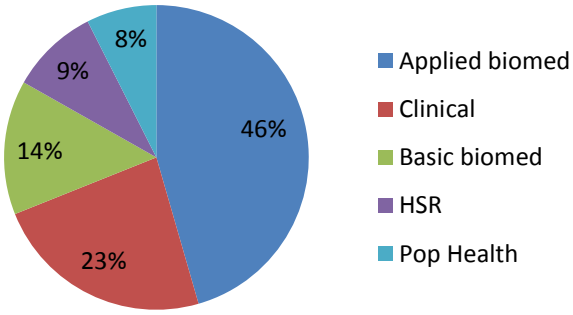


Figure 10 shows the distribution of publications across the five broad research areas. Consistent with the findings in several other bibliometric studies, the biomedical and clinical sciences produced more peer-reviewed publications in the international literature (per €1 million spend) than Health Services Research or Population Health Sciences. The latter fields tend to produce other publications such as book chapters, reports, and other types of 'grey literature'.

Figure 10: Breakdown of peer-reviewed publications by broad research area of grant



No. Papers per €1m spend	
Basic biomedical	10.3
Applied biomedical	9
Clinical research	9.6
Population Health	9
HSR	5

Journal impact factor analysis

The breakdown of peer-reviewed publications by journal Impact Factor (IF) was examined, using Thomson-Reuter's Journal Citation Reports (2011 edition). It must be noted that IFs are an imperfect measure of the quality and importance of published research and there are significant field-specific variations. However, they give some indication of the significance and prestige of journals in which researchers publish their articles.

Figure 11 shows the distribution of journal impact scores categorised into low, medium, high and very high, as well as the proportion of journals that were not indexed by Thomson Reuters in their Journal Citation Reports (12% of all publications). When the latter category is excluded from the analysis, over half of publications (57%) arising from 2010/2011 grants are within the medium impact category (IF of

between 2 and 5), with a further 28 per cent in the high (IF>5) to very high (IF>10) impact category. This compares similarly to the impact scores of 2008/2009 publications (55% of papers published in journals with a medium impact factor, 31% in journals with high to very high impact factors.)

Figure 11: Journal impact factors of HRB-funded publications

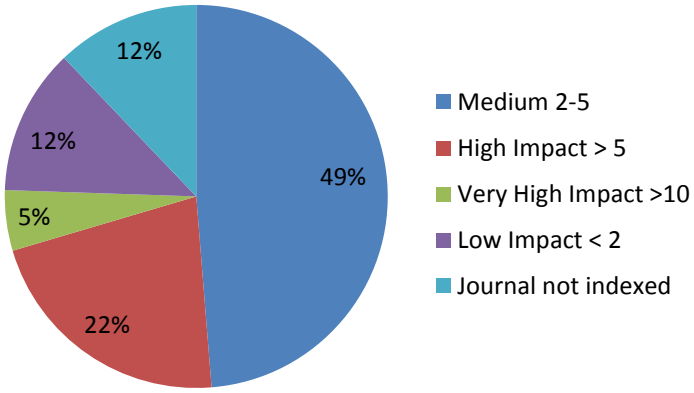
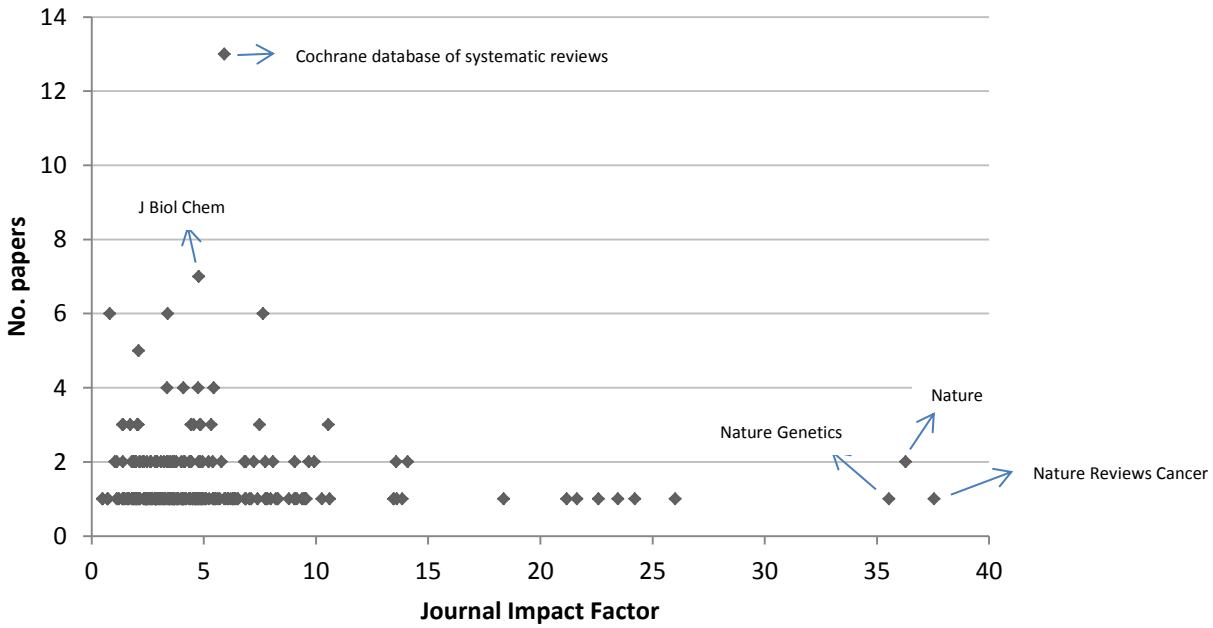


Figure 12 plots the frequency of publications in journals against the journal impact factor and shows that the two most common journals that HRB-funded researchers published in were the Cochrane Journal of Systematic Reviews (IF=5.92) and the Journal of Biological Chemistry (IF=4.77). However, the plot confirms that HRB-funded researchers publish in a very wide variety of journals, mostly with an IF of between 2 and 10.

Figure 12: Scatter plot of frequency of publication versus Journal impact factor



A breakdown of the overall publication rate and average journal impact factor per grant type is illustrated in Table 2. In average terms, programmatic grants produce the most publications per grant but not, on average, in journals of a higher impact score than other grant types. Looking at it from the point of view of productivity per €1 million spend, fellowships and project grants produce the most papers. Papers arising from project grants are published, on average, in journals with higher impact scores than other grant types, although the difference is very slight compared to fellowship and programme grant publications.

Table 2: Breakdown of publication rate and average impact factor by grant type for 2010/2011 grants completed

Grant Type	Average no. papers per grant	No. papers per €1 million spend	Average journal impact factor
Project	2.3	10	5.1
Programme	7.4	6	4.9
Fellowship	1.8	11	5
MRCG*	1.6	8	4.6
Partnership*	0.8	5	4.2
GHRA	2.8	7	3.8

* Financial contribution of charities was taken into account for MRCG grants, and funding contribution of co-funding partners was factored in for the Partnership awards

Table 3: Breakdown of publication rate and average impact factor by grant type for 2008/2009 grants completed

Grant Type	Average no. papers per grant	No. papers per €1 million spend	Average journal impact factor
Project	2.6	12	4.7
Programme	9	9	4.9
Fellowship	2.5	13	4
MRCG	2.2	16	4.1
Partnership	0.5	4.5	2.2
Other*	1.3	8	4.6

* Other category comprises four Health Information System awards, two North-South cooperative project grants, and one Global Health Research award. MRCG grant amounts include the charities' contribution.

Comparison to 2008/2009 data

Comparing the 2010/2011 data to similar data for grants that ended in 2008/2009 (see Table 3 above) shows an apparent decrease in productivity (no. papers produced per grant and per €million spend) which was explained in Section 3.1 (top of page 13). However, in terms of overall data trends, the message is generally consistent – on average, programme grants do not produce as many papers as projects and fellowships, nor are the papers published in journals with a significantly higher journal impact factor. It would be interesting to see if there are any significant differences between

programmatic publications and project/fellowship publications in terms of citation impact – the 2000-2009 outcomes mapping project aims to examine this through a bibliometric analysis.

Top ten HRB-funded publications

For further interest, a list of HRB-funded publications that featured in the ten highest impact journals (i.e. as measured by journal impact factor) is included in Table 4. Of note is that most of the high impact papers are linked to project grants rather than programmatic grants. However, caution is advised when interpreting this data as other (perhaps more significant) funding inputs, both HRB and external, will invariably have contributed to the research that underpinned these publications e.g. Prof Hardiman also attributed her CSA funding to her Lancet Neurology funding in interim reports submitted to the HRB.

Table 4: Top ten publications linked to HRB funded grants completed in 2010/2011 (ranked by journal impact factor)

Grant Type / PI	Article Title	Journal (Year published)	Journal Impact factor	Citations to date
Research Project - Prof Tom Cotter (UCC)	Cotter TG. Apoptosis and cancer: the genesis of a research field.	Nature Reviews Cancer (2009)	37.5	190
Programme: Autism Genome Project - Profs Michael Gill (TCD) & Sean Ennis (UCD)	Gene Discovery Project of the Autism Consortium; Functional impact of global rare copy number variation in autism spectrum disorders.	Nature (2010)	36.3	445
Programme: Autism Genome Project	Gene Discovery Project of the Autism Consortium; A genome-wide linkage and association scan reveals novel loci for autism.	Nature (2009)	36.3	199
Research Project – Prof Orla Hardiman (Beaumont Hosp)	Van Es MA et al; Genome-wide association study identifies 19p13.3 (UNC13A) and 9p21.2 as susceptibility loci for sporadic amyotrophic lateral sclerosis.	Nature Genetics (2009)	35.5	110
Research Project – Dr Anne McGettrick (TCD)	McGettrick, A.F et al; TAG, a splice variant of TRAM, negatively regulates the MyD88-independent TLR4 pathway.	Nature Immunology (2009)	26.0	46
Research Project – Prof Orla Hardiman (Beaumont Hosp)	Shatunov A et al. Chromosome 9p21 in sporadic amyotrophic lateral sclerosis in the UK and seven other countries: a genome-wide association study.	Lancet Neurology (2011)	23.5	76
Health Professional Fellowship – Dr Helen Heneghan	Paranjape T*, Heneghan HM* et al. A 3' UTR KRAS-variant miRNA binding suite is a genetic marker of risk for triple negative breast cancer.	Lancet Oncology (2011)	22.6	21

Research Project – Prof Seamus Martin (TCD)	Lüthi AU et al. Suppression of interleukin-33 bioactivity through proteolysis by apoptotic caspases.	Immunity (2009)	21.6	158
Research Project – Prof Kingston Mills (TCD)	Sutton et al; IL-1 and IL-23 induce innate IL-17 production from gamma delta T cells, amplifying Th17 responses and autoimmunity.	Immunity (2009)	21.6	346
Research Project – Dr Derek Walsh (DCU)	Walsh D. & Mohr I. Viral subversion of the host cell protein synthesis machinery.	Nature Reviews Microbiology (2011)	21.2	22

3.1.2 Scientific Presentations

The extent to which researchers present their work to scientific peers at national and international scientific meetings is an indicator of international involvement and recognition. Figure 13 shows the number and type of scientific presentations per grant type, while Table 5 shows the number of dissemination events per €million spend per grant type. Of the 196 grants that completed in 2010 and 2011, 87 per cent of grant holders reported some type of scientific dissemination event to present their HRB-funded research findings. This is slightly down on the statistic from 2008 and 2009 grants, where a total of 92 per cent of grant holders had presented the results of their HRB-funded research at scientific meetings and conferences.

Importantly, HRB-funded grant holders appear to be very active on the international scientific stage as presentations (both oral and poster) at international conferences was the most common dissemination type. Invitations to deliver keynote talks at international conferences are also an important indicator of scientific recognition and prestige among the international community. HRB grant holders delivered 35 keynote talks at international meetings, while an additional 38 keynote talks at nationally-hosted scientific meetings were reported.

Figure 13: No. scientific presentations linked to grants completed 2010/2011

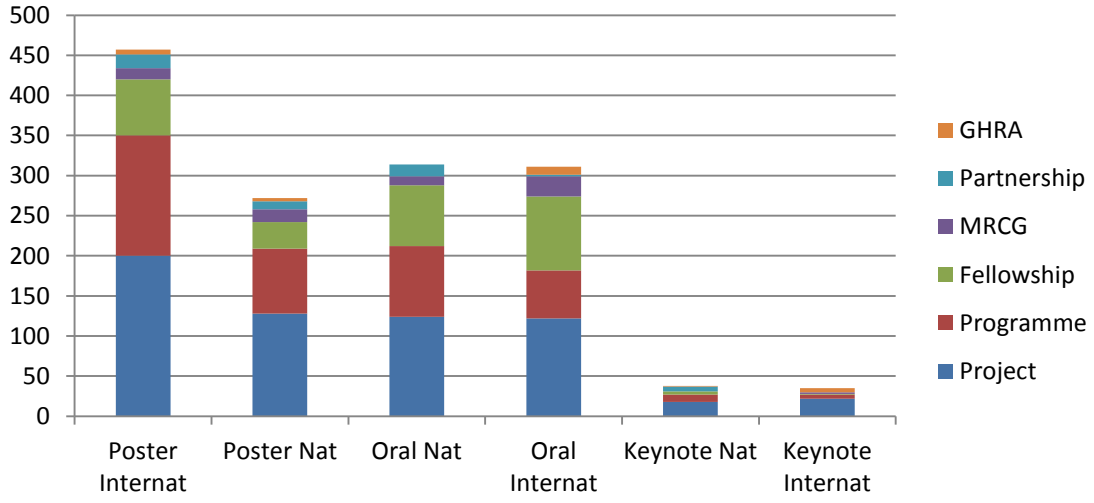


Table 5: Number of scientific dissemination events per €1 million spend per grant type

	Internat. Oral	Internat. Poster	Internat. Keynote	National Oral	National Poster	National Keynote
Project	4.8	7.9	0.9	4.9	5.1	0.7
Programme	3.7	9.2	0.3	5.4	5.0	0.6
Fellowship	9.9	7.5	0.1	8.2	3.5	0.4
MRCG	16.7	9.3	1.3	7.3	10.7	0
Partnership	1.5	12.1	0	10.7	7.1	4.3
GHRA	4.3	2.6	2.2	0	1.7	0.4

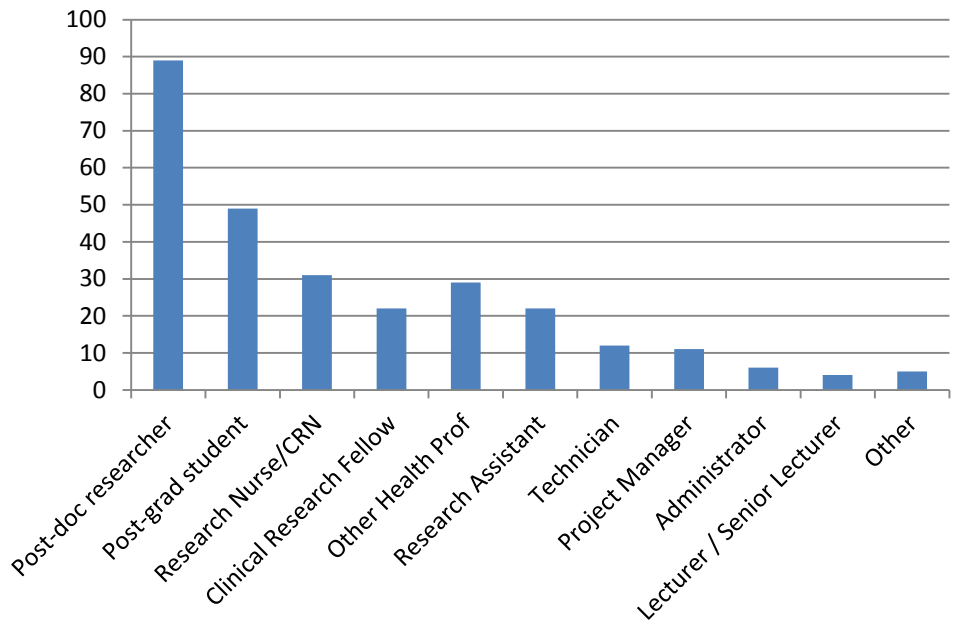
3.2 Research capacity-building

3.2.1 Human Capacity outputs

Types of personnel funded

In total, 280 research-related jobs were directly created through the 196 HRB grants that completed in 2010 and 2011 – the equivalent statistic from the 204 grants that completed in 2008/2009 was 296 jobs. A breakdown of the total research personnel supported on 2010/2011 HRB grants is given in Figure 17. The figure shows that at least 82 personnel came from a health professional background, representing 29% of the total personnel cohort. For strategic information purposes, the health professional groupings have been separated out – thus, the category of Clinical Research Fellow is for personnel with a medical background (a third of this group had registered for a PhD), Research Nurse / Clinical Research Nurse includes those from a nursing, midwifery, and clinical research nursing background (a third of this group had also registered for a PhD), while the category of Other Health Professional includes personnel with a background in allied healthcare professions such as physiotherapy, speech and language therapy, occupational therapy and so on (just over a third of this group had registered for a PhD).

Figure 17: No. of personnel funded on HRB grants by personnel type



Numbers of Post-doctoral researchers and PhD students funded by broad pillar area

Table 7a and 7b below give a breakdown by broad research area of the total number of post-doctoral researchers (204 in total – 112 in 2008/2009 and 92 in 2010/2011), and the total number of PhD students (160 in total – 88 in 2008/2009 and 72 in 2010/2011). The figures are presented as a percentage of the total numbers for each year. The data shows a slight decrease in the proportion of

post-docs and PhDs funded in basic biomedical research across the four years period. The 2010/2011 figures show a slight increase in the proportion of both post-docs and PhDs funded in Health Services Research compared to 2008/2009. However, there was a slight decrease in the proportion of both post-docs and PhDs in Population Health Sciences. Taken as a whole across the four years, the figures show that Biomedical research (basic and applied combined) accounted for 83% of post-docs and 52% of PhDs. This statistic confirms the need for both the HSRI PhD initiative and the ICE Post-doctoral initiative targeted at Population Health Sciences and Health Services Research.

Table 7a: Breakdown of Post-docs by broad pillar areas (proportion of post-docs in each pillar area expressed as a percentage of the total number for each 2-year period)

Broad pillar area	2008/2009	2010/2011	Total numbers (2008-2011)
Basic Biomedical	29%	24%	54
Applied Biomedical	55%	59%	115
Clinical Research	11%	11%	22
Health Services Research	2%	4%	6
Population Health	4%	2%	7
Total	**100%**	**100%**	**204**

Table 7b: Breakdown of PhDs by broad pillar areas (proportion of PhDs in each pillar area expressed as a percentage of the total number for each 2-year period)

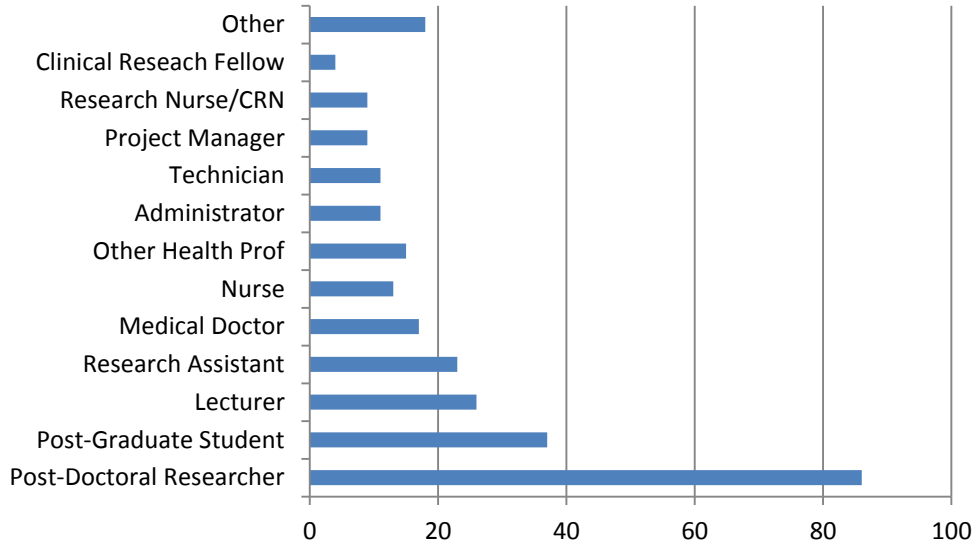
Broad pillar area	2008/2009	2010/2011	Total numbers (2008-2011)
Basic Biomedical	15%	11%	21
Applied Biomedical	39%	39%	62
Clinical Research	18%	18%	29
Health Services Research	17%	24%	32
Population Health	11%	8%	16
Total	**100%**	**100%**	**160**

* Both tables include all people at post-doc level or registered for PhD regardless of professional background - thus the total number of post-docs and PhDs exceeds those for the Post-doc and Post-grad categories in Figure 3

Employment destinations of personnel

Grant holders were asked to provide information in relation to the current employment positions of research personnel supported by HRB grants. Figure 18 shows the overall breakdown of current employment positions. Consistent with the 2008/2009 figures, by far the most common follow-on employment role was a post-doctoral researcher in a higher education setting (31% of personnel). The second most common position was held by those who were still completing (or who had just commenced) a PhD studentship (13%), while a further 9 per cent had secured a lectureship position. Of note was that 45 people (16% of all personnel) indicated that they were now predominantly employed in the health sector, either as a medical clinician (N=17) or an allied health professional.

Figure 18: Current employment positions of HRB grant personnel

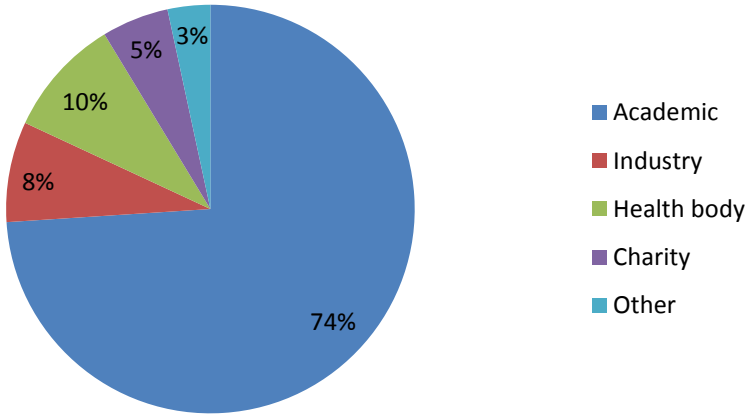


The 'Other' category comprised individuals who moved into industry or were "self-employed" (N=5), those who had moved outside of research in their current employment (N=9), or those who were unemployed or retired (N=4). In terms of current location, over three-quarters of total personnel (77.5%) were currently employed in Ireland or Northern Ireland, while the remainder were based overseas. The most common locations were the UK (N=16), the US (N=13), and Africa (N=13), the latter comprising of staff who had been employed on a global health research project.

3.2.2 Research Collaborations and Partnerships

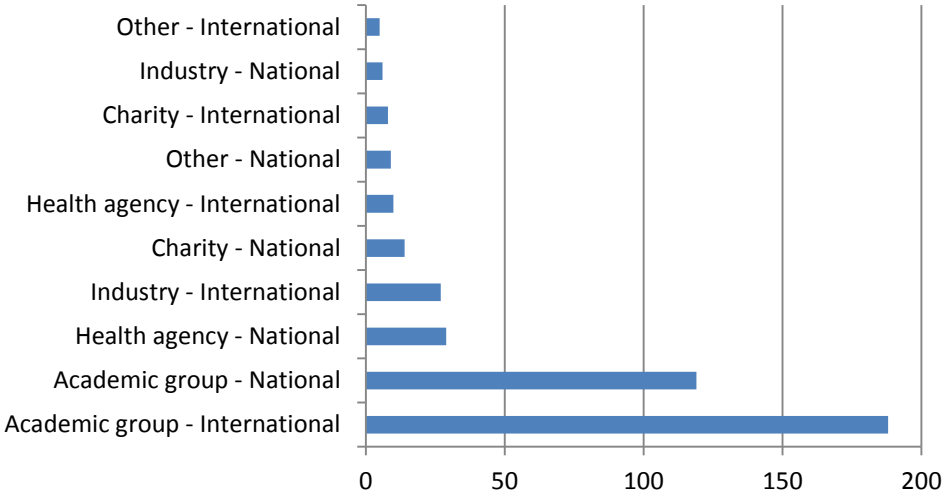
The development of collaborations and partnerships with national and international researchers, industry, charities, and professional health bodies is an important indicator of the quality and potential impact of HRB-funded research. From grants completing in 2010/2011, 145 grant-holders (or 74 per cent of all grant holders) reported the establishment of 415 new collaborations or partnerships during the lifetime of the HRB grant. This represents a slight increase on the 2008 and 2009 statistic, where 72 per cent of grant holders reported the establishment of 384 new collaborations during the lifetime of the HRB grant. A breakdown of the 415 collaborations by type is provided in Figure 14 below.

Figure 14: Breakdown of collaborations formed by HRB-funded researchers by type



A further breakdown of new collaborations formed is shown in Figure 15. As can be clearly seen, the most common form of collaboration reported was one involving an academic researcher based overseas.

Figure 15: Number of collaborations by type – national and international



3.2.3 Development of Research Materials and Methodologies

The development or application of novel research materials, methodologies and/or technologies is an indicator of the extent to which HRB grant holders are advancing research capacity within their field both locally and/or internationally. Of the 92 grants that completed in 2011, 46 per cent of grant holders reported the development of a novel research material wholly or partly as a result of their HRB grant (the question was not asked in 2010, hence data is presented for 2011 only). As shown in Table 6, the most common type of research material developed was a novel database or dataset, followed by a novel data analysis technique, experimental assay, and physiological assessment or clinical outcome measure.

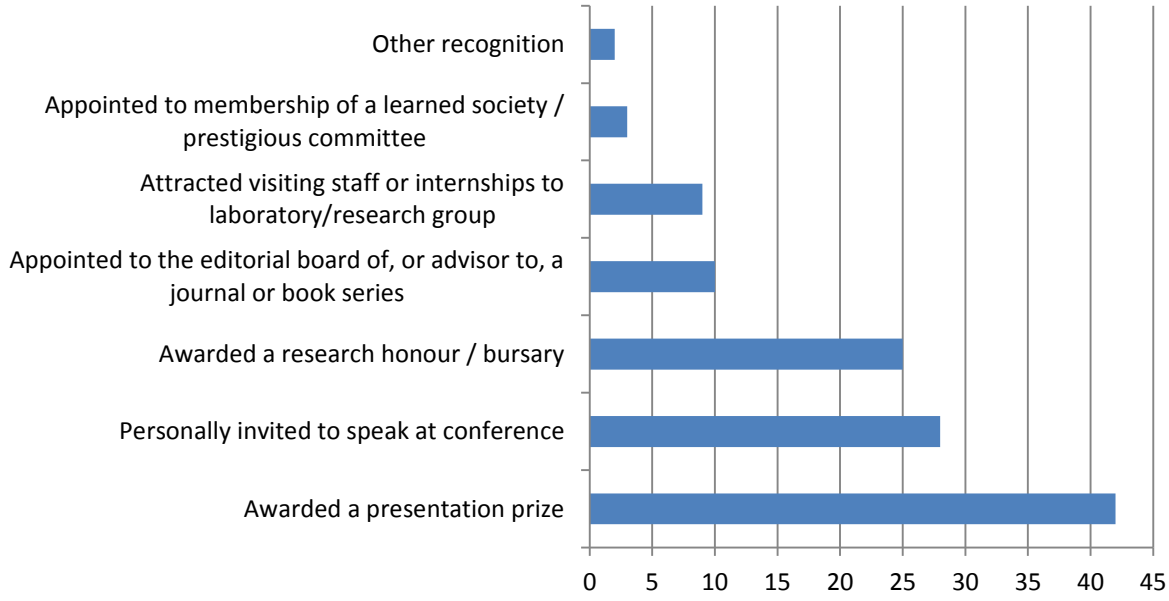
Table 6: Number of novel research materials developed by type

Type of novel research material	No. developed
Database / Dataset	15
Data analysis technique	10
Experimental assay or reagent	10
Physiological assessment or clinical outcome measure	10
Animal model of disease	8
Biological samples / Biobank	7
New software	7
New or improved research infrastructure	7
Computational model	6
Cell line	5
Total no. of new research materials	**85**

3.2.4 Research Awards and Recognition

A new section was introduced into end-of-grant reports from 2011 onwards. Grant-holders whose grants completed in 2011 (N=92 grants) were asked if they, or any members of their HRB-funded team, had received any awards or recognition related to their HRB-funded research during the period of the grant. Awards and recognition received by grant-holders gives an indication of the quality and impact of grant-holders' research as perceived by their research peers nationally and internationally. In this context, it was highly encouraging that 75% of grant-holders reported that either they or a HRB-funded member of their team received at least one type of award or recognition (see Figure 16 for details).

Figure 16: Number of grants reporting different types of awards and recognition



Examples of research awards and prizes

Grant	Details of Award
PA/2008/26 PI: Dr Ken McDonald	2010 Product Innovation Award Winner – Aramark Healthcare Innovation Awards for the 'Heartphone', a device for remote monitoring of Congestive Heart Failure
RP/2007/79 PI: Dr Deirdre Hurley	Dr Deirdre Hurley received Outstanding abstract and research report platform presentation award at the 16th International Congress of the World Confederation for Physical Therapy, Amsterdam, The Netherlands (23rd June 2011) for presentation of main results of this project.
RP/2007/85 PI: Dr Orla Hardiman	The PI received the prestigious Sheila Essay Award for ALS Research at the American Academy of Neurology meeting in 2009
RP/2008/220 PI: Prof Finbarr Allen	The PI was awarded a distinguished scientist award by the International Association for Dental Research in 2011. This award was for significant contribution to geriatric oral health research.
HS/2005/6 PI: Dr Mary Fitzsimons	Irish Medical Times Healthcare Award for project: An Electronic Patient Record to Improve the Health and Healthcare of People with Epilepsy. Commendation in the Excellence in Healthcare Management category. PI invited as a guest editor to a special edition of the journal "Epilepsy Research and Treatment" issue entitled "Future Challenges and Solutions in the Worldwide Delivery of Epilepsy Care"
RP/2007/174 PI: Prof Michael Kerin	Sir Peter Freyer Memorial Medal was awarded to the post-doc on this project Dr Aoife Lowery for her presentation entitled: Identification of MicroRNA Function in Breast Cancer -Expression Profiling and Target Determination on her data generated from this research.
RP/2006/105 PI: Dr Patricia Fitzpatrick	The PI was an invited member of the Local Scientific Advisory Committee for the European Association of Cardiovascular Prevention and Rehabilitation's (EACPR) annual congress "EuroPrevent 2012."

3.3 Informing policy, practice and the public

3.3.1 Health policy and practice outputs and influences

A key area in terms of assessing the impact of HRB-funded research relates to health sector impacts and specifically, outputs and activities that may influence health policy, clinical practice and patient care. In EOG reports, grant holders were asked to describe any activities undertaken that may lead to an impact in these areas, including:

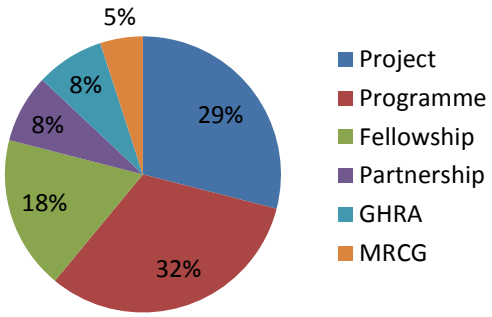
- Any reports, guidelines, policy briefs, handbooks and so on that were targeted at health policy-makers or practitioners
- Any interactions (such as meetings, seminars hosted) they had with potential research beneficiaries/users in health policy or clinical practice sectors
- Any advisory roles or expert group memberships (e.g. guideline committee, policy development group) linked to their HRB-funded research
- Any instances of their HRB-funded research being cited or referred to in key clinical or health policy documents, or their research findings being used to inform the education or training of health professionals or policy-makers

In total, 48 grants (or 24% of all grants) reported activity in this area – this compares to 41 grants (or 20% of all grants) that completed in 2008/2009 reporting outcomes in this category. Table 8 below shows the breakdown of the policy/practice outputs and influences by sub-type; Figure 19 shows the distribution of influences by grant type and Figure 20 shows the distribution of influences by research classification.

Table 8 – Breakdown of policy/practice outputs and influences by sub-type

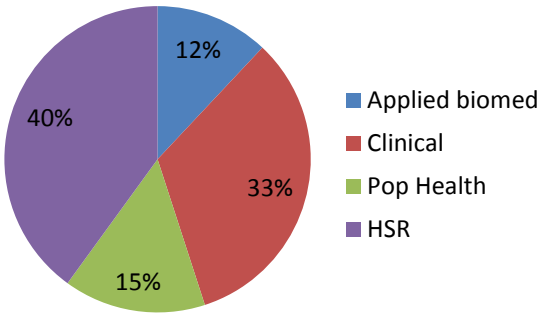
Output / influence sub-categories	% grants reporting activity
Met with policy-makers to discuss findings or presented at seminars aimed at policy-makers	11.2%
Research findings are informing training or education of health professionals or policy-makers	8.1%
PI is a member of a guideline committee or advisory group	7.1%
Published a report, guideline, brief or handbook aimed at policy-makers or health practitioners	5.6%
PI made submission to government or gave evidence to an Oireachtas committee	4.6%
Produced a systematic review or HRB-funded research was cited in a systematic review	4.1%
PI participated in a national service/policy/legislative consultation or forum	3%
HRB-funded research was cited in key policy documents	3%
HRB-funded research was cited in clinical or treatment guidelines	2%
Other	1.5%

Figure 19 – Influences broken down by grant type



No. reported policy/practice influences per €1m spend	
Project	1.1
Programme	2
Fellowship	2
Partnership award	5.5
GHRA	3.5
MRCG	3.4

Figure 20 – Influences broken down by broad area classification of grant



No. reported policy/practice influences per €1m spend	
Basic biomedical	0
Applied biomedical	0.5
Clinical research	3
Population Health	4
HSR	4.5

Examples of policy and practice influences

Grant	Details of Influence
SA/2004/13 PI: Prof Helen Whelton Developing evidence-based clinical practice guidelines for the dental services in Ireland	**Type: Produced guideline, report, brief or handbook aimed at policy-makers or health practitioners** This programme produced and published 4 guidelines: 1 - Irish Oral Health Services Guideline Initiative. Topical Fluorides: Evidence-based guidance on the use of topical fluorides for caries prevention in children and adolescents in Ireland. 2008. 2 - Irish Oral Health Services Guideline Initiative. Strategies to prevent dental caries in children and adolescents: Evidence-based guidance on identifying high caries risk children and developing preventive strategies for high caries risk children in Ireland. 2009. 3 - Irish Oral Health Services Guideline Initiative. Pit and Fissure Sealants:

	Evidence-based guidance on the use of sealants for the prevention and management of pit and fissure caries. 2010. 4 - Irish Oral Health Services Guideline Initiative. Oral Health Assessment: Best practice guidance on providing a programme of oral health assessment for school-aged children in Ireland. 2011.
HS/2005/7 PI: Prof Carol Fitzpatrick Adolescent Depression and Suicidal Behaviour – Making Knowledge Work for Health	**Type: Meetings with decision-makers or presented at seminars aimed at decision-makers** PI had numerous meetings with SPHE Support Service of Dept. of Education and Science. We invited a representative of the National Educational Psychology Service to join our Steering Committee. Launch of Working Things Out Adolescent Mental Health Programme by Minister Frances Fitzgerald, Hogan Suite, Croke Park, September 2011 (attended by over 700 delegates). Launch of Working Things Out through SPHE Teacher's Resource Manual by Senator Joe O'Toole, Mater Hospital, September 2010.
TRA/2006/4 PI: Prof Hilary Humphries Reducing hospital infections caused by MRSA by effective environmental decontamination and effective hand hygiene	**Type: Cited in clinical or treatment guidelines** Our findings on the relevance of rapid diagnostic techniques for MRSA and the confirmation that targeted screening, rather than screening all patients admitted to hospital with MRSA (with the associated published papers) will be cited in national guidelines on the prevention and control of MRSA that are being currently drafted by a national group, chaired by the PI.
GHRA/2007/10 PI: Prof Sam McConkey Evaluate the use of systematic national surveillance to inform decision-making in malaria prevention and control in The Gambia	**Type: Citation in key policy documents** Research cited in Common Country Assessment, The Gambia, February 2011. This report provides the background/rationale for the United Nations Development Assistance Framework for the Gambia for 2012 to 2015. Research also cited in The Gambia National Malaria Indicator Survey 2010 – Survey Protocol published by Ministry of Health & Social Welfare, June 2010
CTF/2008/8 Fellow: Dr Margaret Walshe Treatment of Drooling in Children with Cerebral Palsy	**Type: Membership of a guideline committee or advisory group** I have now been appointed to the European working group for the development of clinical guidelines on drooling for children with cerebral palsy. Therefore findings from my review will form the basis of European clinical guidelines on the management of drooling in children with cerebral palsy. Details of Cochrane review published: Walshe M, Smith M, Pennington L. Interventions for drooling in children with cerebral palsy. Cochrane Database of Systematic Reviews 2012, Issue 2. Art. No.: CD008624. DOI: 10.1002/14651858.CD008624.pub2.
MRCG/2007/8 PI: Dr Sean Dineen – Galway diabetic foot study	**Type: Made submission to government or gave evidence to an Oireachtas committee** Dr Sean Dinneen was part of a delegation that met with a Health Committee in Oireachtas Eireann on 11/11/2009 to highlight the burden of diabetic foot disease

3.3.2 Engagement of Patients and the Public

Wider dissemination of research findings to non-scientific audiences is critical for improving the public understanding of science, for engaging patients in research, and for promoting the benefits and value of health research to non-scientific stakeholers. When asked if they had engaged in wider dissemination of their research through various fora, 35 per cent of grant holders reported activities in this area.

Figure 21 below shows the distribution of dissemination events reported by HRB grant holders according to the media type. Coverage of research in the national and international press was the most common outlet, followed by presentations to lay audiences (general public, patients / patient groups, school talks etc), radio or television interviews relevant to their HRB-funded research, reference to their research in newsletters or online publications, and finally a press release describing significant research findings. The distribution of dissemination events across the five broad health research areas is displayed in Figure 22.

Figure 21: Breakdown of dissemination events by media type

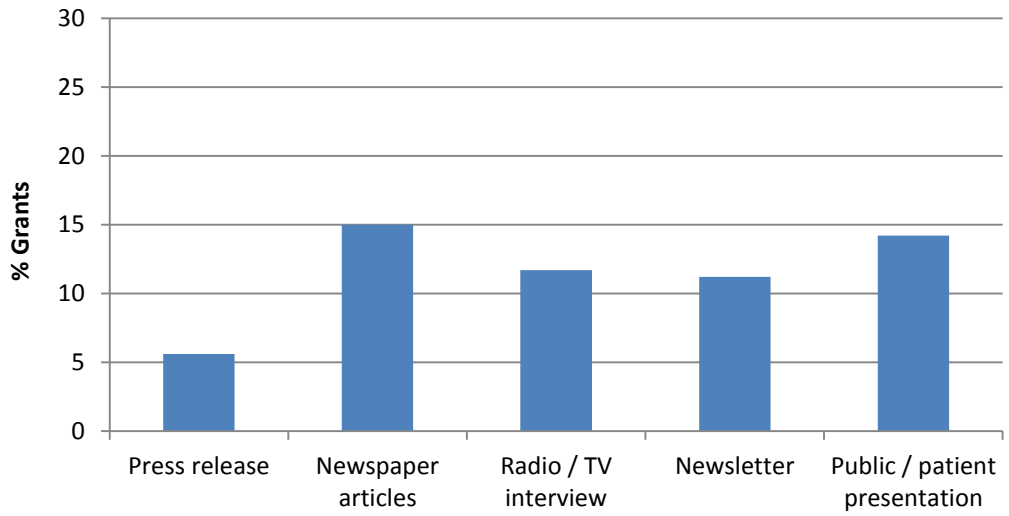
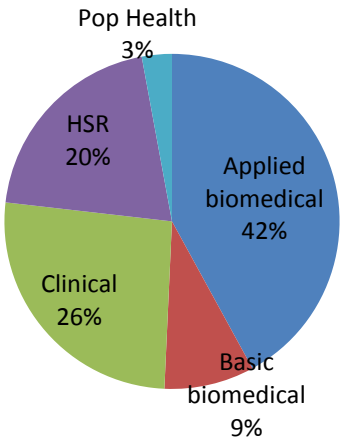


Figure 22: Breakdown of dissemination events by broad research area of grant



Examples of dissemination events

Grant	Details of Activities
AUT/2006/1 Autism Genome Project	1. Irish Independent. 9th June 2010. New autism genes discovered 2. Irish Times. 10th June 2010. International research team discovers gene link to autism 3. Irish Medical Times 10th June 2010. Irish key role in global genome project 4. Business and Finance 14th June 2010. LIFE SCIENCES: Irish researchers discover new autism gene 5. SiliconRepublic.com Ireland 14th June 2010. Irish researchers study of autism genes causes international stir
SA/2004/13 PI: Prof Helen Whelton Developing evidence-based clinical practice guidelines for the dental services in Ireland	1. Irish Times, Tuesday 23rd December 2008: 'Advice on use of dental fluoride products.' 2. Irish Times, Saturday 10th October 2009. 'Half those aged 12 have tooth decay.' 3. Irish Medical News. Monday 12th October 2009. 'Guidelines to prevent tooth decay in children produced.' 4. Irish Examiner, Saturday 10th October 2009. 'A quarter of three-year-olds suffer tooth decay.' 5. Evening Herald, Monday 28th September 2009. 'Over half of Irish teens suffer tooth decay.'
MRCG/2007/8 PI: Dr Sean Dineen – Galway diabetic foot study	The Diabetes Federation of Ireland highlighted the study in their news item section of their website in July 2008 and in their correspondence to members. Preliminary baseline findings were communicated by the DFI to its members via correspondence in February 2010. The cost analysis study on the diabetic foot was published in *Diabetes Professional.*
HS/2006/13 PI: Dr Hilary Dunne The continuous evaluation of Patient Perception of Acute Hospital In-Patient Care in Ireland	Research findings reported on by: RTE News (1 pm 24/06/2011), RTE News (6:01 pm 24/06/2011), Northern Sound (94-98 FM at 1.20 31/01/2011), Spin Mid-Western, and RTE Radio. Radio interview on: News Talk - Sound bites (24/06/2011) and Today FM, The Last Word with Matt Cooper (24/06/2011)
RP/2007/75 PI: Dr Mark Tangney Bifidobacteria mediated cancer gene therapy	April 2010: Articles in >20 national and local newspapers. April 13 - Irish Times, Irish Examiner (front page), Independent + many more. TV - April 13: RTE1 6pm news, RTE afternoon show, TG4 news; Radio: RTE Radio1 Morning Ireland, Newstalk Right Hook + many more. April 13-17: >20 radio interviews.

3.4 Health sector innovations

It is well recognised that health research is the basis for many product innovations in the commercial life sciences /biotech sector as well as treatment and service innovations in the health sector. In this context, grant-holders were asked whether their HRB-funded research led to, or significantly contributed to, the development of any health-related innovations. Such innovations were defined broadly to include products (eg diagnostics, drugs, devices), non-drug interventions, health IT systems, clinical decision support tools, disease management strategies, clinical care models, health services and so on. Grant-holders were also asked about the stage of development of the innovation along the discovery-development continuum and were asked to provide a description of the innovation.

In total, 41 grants (21% of total grants) reported that their HRB-funded research had either led to or directly contributed to the development of a total of 48 innovations – this is an increase on 2008/2009 figures where a total of 31 grants (15%) reported the development of 32 health innovations. Table 9 below shows the breakdown of the 48 innovations by sub-type; Figure 23 plots the stages of development of the innovations; Figure 24 shows the distribution of innovations by grant type and Figure 25 shows the distribution of innovations by research classification.

Table 9 – Number of HRB-funded health-related innovations in development by type

Type of Innovation	No. developed
Therapeutic intervention – New drug or vaccine	9
Diagnostic Tool – Non imaging	8
Preventative Intervention – Behavioural Risk Modification	6
Therapeutic intervention – Psychological/Behavioural	5
New ICT-based health technology	5
Therapeutic intervention – Stem cell or gene therapy	4
Prognostic Tool (Imaging, Algorithm or other)	3
Strategy to manage disease or condition	2
Health care model or service	2
Therapeutic intervention - Medical device	1
Diagnostic Tool - Imaging	1
Clinical Decision Support Tool	1
Other – Rating Scale for Patient Healthcare Experience	1
Total	**48**

Figure 23 - Stages of development of HRB-funded health innovations

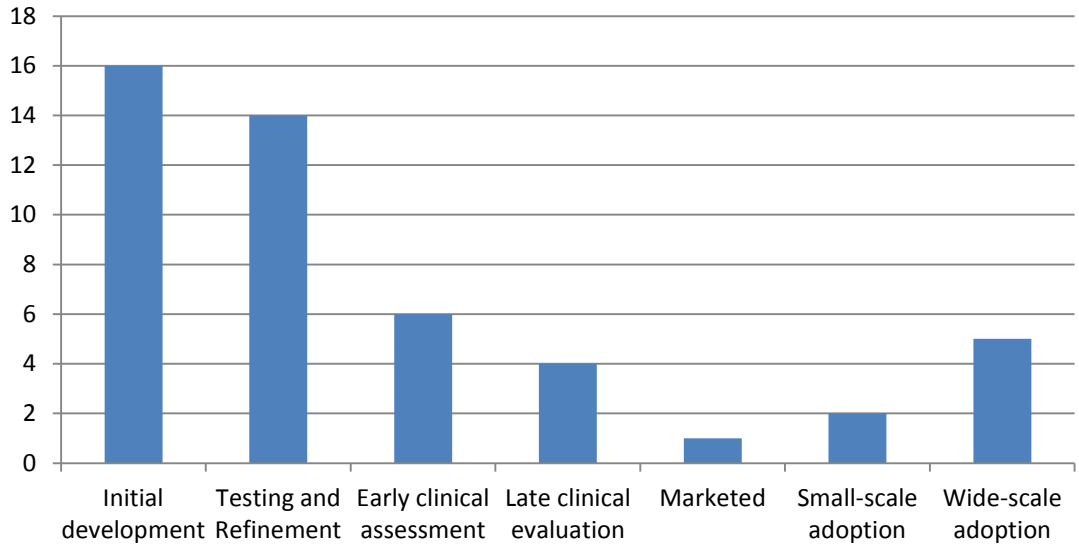
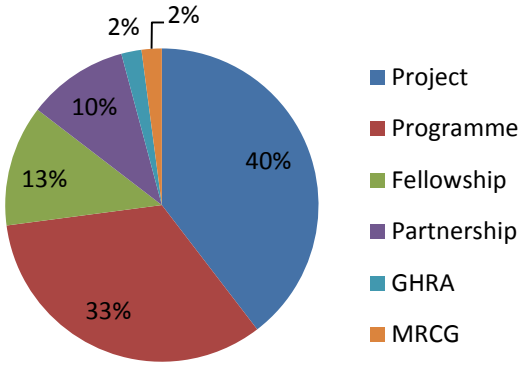
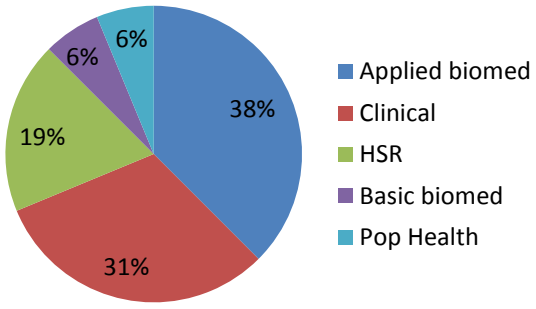


Figure 24 – Innovations broken down by grant type



No. innovations per €1m spend	
Project	0.75
Programme	1
Fellowship	0.6
Partnership	3.5
GHRA	0.4
MRCG	0.7

Figure 25 – Innovations broken down by strategic pillar area



No. innovations per €1m spend	
Basic biomedical	0.5
Applied biomedical	0.75
Clinical research	1.3
Population Health	0.8
HSR	1

Examples of innovations in development

Grant	Details of Innovation
RP/2007/75 PI: Dr Mark Tangney Bifidobacteria mediated cancer gene therapy	**Type: Therapeutic Intervention – Stem cell or gene therapy** Bacterial Vector under preclinical development, aimed at commencing clinical trial within 2-3 years. Current active funding from HRB Health Research Awards "Clinical development of a tumour diagnostic/therapeutic system utilizing non-pathogenic bacteria" HRA_POR/2010/138, "Probiotic Bacterial Trafficking To Tumours In Cancer Patients" HRA_POR/2012/99 and EU FP7-PEOPLE-2009-IOF "Development of a Novel Vector for Cancer Gene Therapy for Clinical Application".
RP/2006/152 PI: Dr Sally-Ann Cryan Particle engineering to target interferon-gamma to alveolar macrophages for the adjunct treatment of multi-drug resistant tuberculosis.	**Type: Therapeutic Intervention – Drug or Vaccine** In this product interferon (IFN)-gamma is coated onto microparticles suitable for inhalation. These microparticles can be pre-loaded with antibiotics. The microparticles have been designed by us to be easily and economically inhaled using a standard dry powder inhaler. Once inhaled the particles target the IFN to alveolar macrophages and prolong activity of the therapeutics through a controlled release mechanism. This platform offers a unique set of pharmaceutical and biopharmaceutical properties to enhance the treatment of respiratory infections by efficient and targeted delivery of drugs to the lung. An invention disclosure for this product has been filed with RCSI TTO and funding is now being sought to carry out pre-clinical trials of the product in a mouse model of TB ahead of full patent filing.
HRA_HSR/2010/3 PI: Dr Sally-Ann Lynch Isolation of disease genes in the Irish Traveller population	**Type: Diagnostic Tool – Non-Imaging** We have developed a genetic test that can be offered, on a research basis, to patients with isolated eye malformations. The test involves mutation screening of the STRA6 gene which we identified in our study. We are currently in discussions with the National Centre for Medical Genetics, Our Lady's Children's Hospital Crumlin (Dublin) to introduce this test into a diagnostic setting. The NCMG offers mutation screening for a number of specific recessive mutations that are common in the Irish Traveller population (such as the mutations for Hurler's syndrome, galactosemia, osteogenesis imperfecta, Bylers disease) and we plan to add the anophthalmia mutation to the testing panel.
HS/2005/6 PI: Dr Mary Fitzsimons Revolutionising Chronic Disease Management with Information and Communication technology: A socio-technical project applied to epilepsy care in	**Type: New ICT system or ICT-based intervention** Successful implementation of the new procedures and operational changes associated with the National Epilepsy Care Programme relies on the deployment of a web-based EPR, which will ensure that clinical information is available when and where needed to authorised clinicians throughout Ireland. This programme has developed and validated an EPR for epilepsy care. Current EPR development work is being done to build on existing functionality to develop appropriate interfaces to support the work of the National Epilepsy Care Programme. It is anticipated that there will be up to

Ireland	170 regular users of the epilepsy EPR throughout Ireland. These include general practitioners, hospital-based clinicians and allied health professionals, and advanced nurse practitioners. In addition as the model of care evolves, a requirement for up to 11,000 patients to have intermittent access to limited modules of the EPR may emerge.
HS/2005/7 PI: Prof Carol Fitzpatrick Adolescent Depression and Suicidal Behaviour – Making Knowledge Work for Health	**Type: Therapeutic Intervention – Psychological/behavioural** 'Working Things Out Adolescent Mental Health Programme' is an eight session group based Cognitive Behavioural Therapy programme for adolescents with mental health difficulties, developed during this study. It also uses animated stories to help young people develop problem solving skills and coping strategies to use when they are feeling low or in despair. It can be used in both clinical and community settings. Evaluation has shown that the programme is successful in helping adolescents develop positive coping strategies, and that young adolescent boys who completed the programme report significant improvements in their positive social behaviours. It has been manualised, successfully launched, and training courses in its delivery have been provided to mental health professionals, counsellors and youth workers from all over Ireland. Dissemination of this programme and training in its delivery has now been taken over by Parents Plus Charity and the Mater Child and Adolescent Mental Health Service
HS/2005/19 PI: Prof Fidelma Dunne ATLANTIC DIP: Atlantic diabetes in pregnancy network. Prospective studies to examine the outcome of pregnancy in diabetic women	**Type: New or revised health care model or service** New combined obstetric-diabetes clinics: As a result of the study the delivery of care has changed to the delivery of combined obstetric diabetes clinics in the 3 antenatal centres in the west region of the study. We have also developed pre-pregnancy clinics for better preparation of women with diabetes before pregnancy. This has resulted in significant improvements in pregnancy outcomes.

3.5 Economic and commercial activity

3.5.1 Further funding obtained

In total, 113 additional grants were secured by 41 per cent of grant holders that were at least partially attained on the back of research findings from their original HRB grant. The combined total value of these 113 grants was €34.77 million, of which 40% (or €13.85 million) came from non-exchequer sources such as EU, charity and industry. Figures 26 and 27 show the breakdown of these 117 leveraged grants according to the funding source of the grant, nationally and internationally.

When considering leveraged funding it is necessary to consider that some new grants may have been awarded on the basis of the participation (rather than primary leadership) of the PI within a wider research consortia. This may be particularly the case for EU grants, which require a consortium of European researchers to be established for an application to be eligible.

Figure 26: No. grants leveraged from various sources

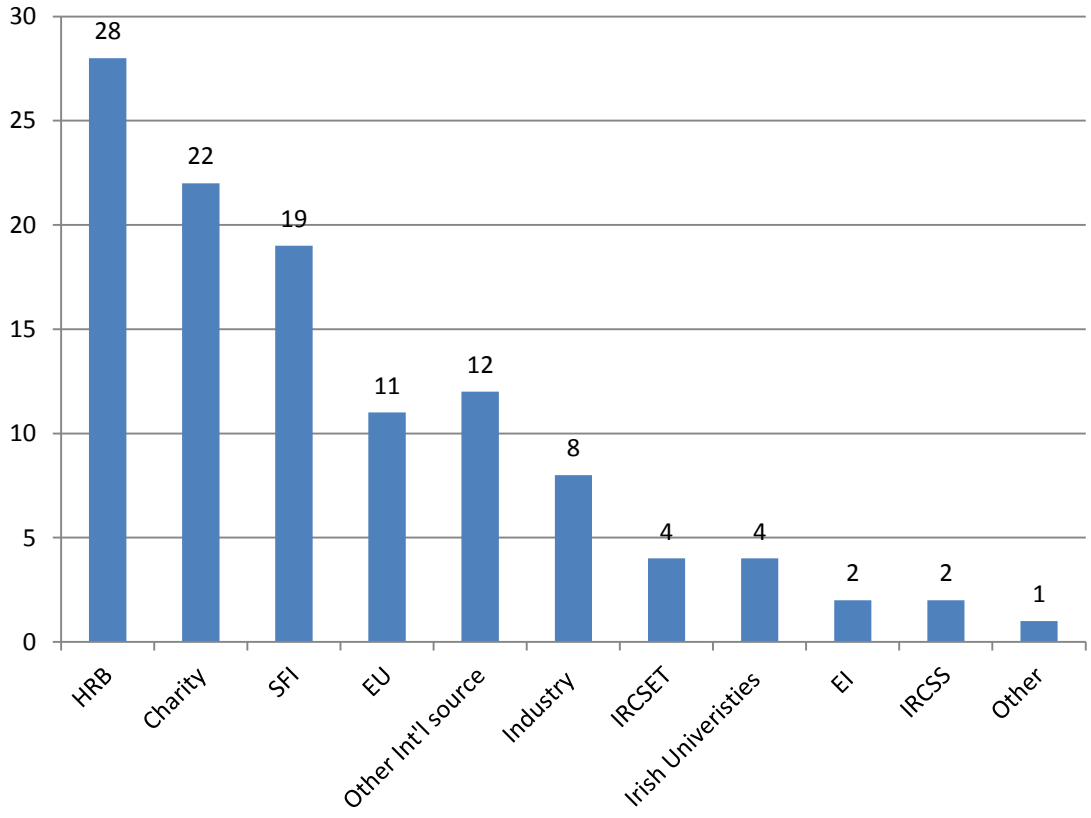
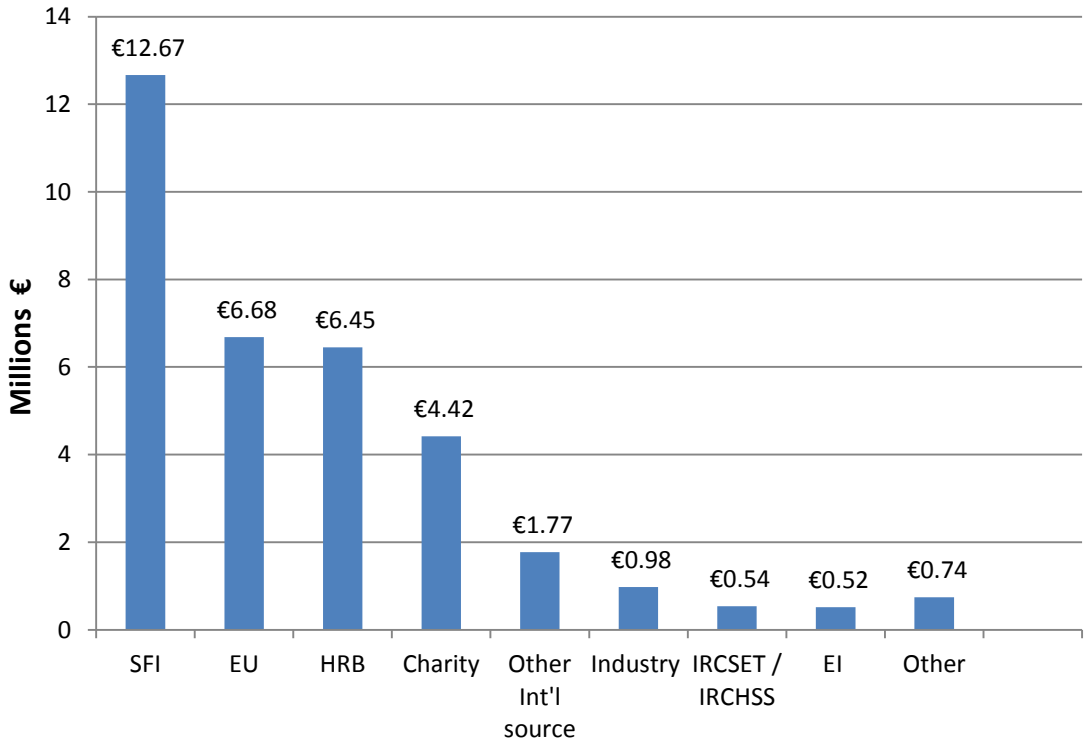


Figure 27: Amounts leveraged from each funding source



The success of PIs funded under the various grant schemes in securing further funding is shown in Table 10 below. Again these figures should be interpreted with caution as some grant-holders may not yet have submitted applications for further funding by the end-of-grant stage. That said, it is disappointing that only 7% of fellowship holders had gone on to secure additional funding by the end of their fellowship.

Table 10: Proportion of grant holders by funding category that secured new grants

Grant Type	% of PI's that had secured additional funding by end-of-grant
Programme	50%
Project	41%
MRCG	29%
Fellowship	7%
Partnership	56%
GHRA	83%

Examples of Leveraged Awards

Grant	Details of Grant Leveraged
PA/2008/6 PI: Dr Anne MacFarlane	Coordinator of successful EU FP7 Health application in 2010 - project RESTORE (a project about optimising medical and psychosocial primary care for migrants in Europe with a particular focus on communication in cross-cultural consultations); €2.9 million
CSA/2007/2 PI: Dr Louise Kenny	A funded grant of €800,000 from The Children's Medical & Research Foundation for "BASELINE, Babies After SCOPE: Evaluating Longitudinal Indices of Neurological and Nutritional Endpoints" A funded Wellcome Trust Translational Grant of €670,000 (Co PI with Professor Phil Baker, Manchester): "The development of a metabolomic based screening test for pre-eclampsia" A funded SFI Principal Investigator programme grant of €444,000 (sole PI) "The development of a metabolomic based screening test for utero-placental insufficiency"
PA/2008/26 PI: Dr Ken McDonald	A grant of €80,000 from Alere Ltd to build on HRB-funded work – grant entitled "Heart Failure (HF) Outpatient Monitoring Evaluation (HOME) Study" ClinicalTrials.gov Identifier: NCT01347567.
AUT/2006/1 PI: Dr Sean Ennis / Prof Michael Gill	National Children's Research Centre - Title: Genomics of paediatric autism spectrum disorder (Applicants – Dr. Sean Ennis/ Prof L Gallagher). This is application to the NCRC for funding support to investigate copy number variation in an existing sample of individuals with autism recruited in Ireland and other European sites. Awarded, June 2011, €300k

3.5.2 Commercialisation and enterprise activity

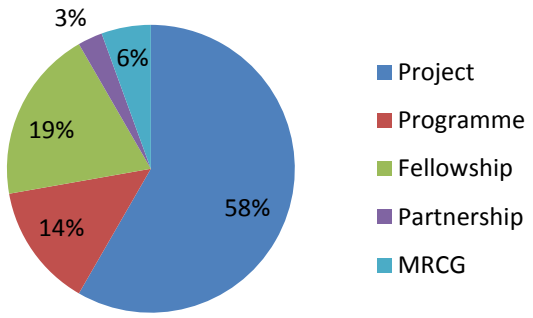
An increasingly important indicator of the impact of publicly-funded research in Ireland is the proportion of research grants that are producing commercializable outputs and the level of collaboration between the academic and industrial sectors. In end-of-grant reports HRB-funded researchers were asked if their research findings had commercial potential and if so, to what extent had they pursued this opportunity in terms of intellectual property protection and various commercialisation routes. Grant-holders were also asked if they had established academic-industry collaborations.

In total, 36 HRB grant-holders (or 18% of total) reported 54 commercial activities - this is an increase on the 2008/2009 statistic of 27 grant-holders (or 13% of total) reporting 42 activities. Table 11 below shows the number of activities by type, while Figures 28 and 29 provide a breakdown of the commercial activities by grant type and grant classification.

Table 11: Number of commercial outputs by type

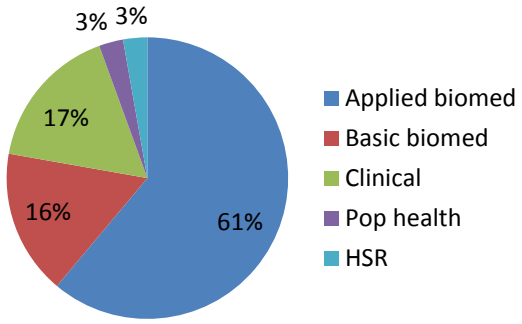
Output Type	2010/2011 No.	2008/2009 No.
Filed invention disclosure or in discussions with TTO	9	9
Patents filed (pending or lapsed status)	11	12
Licenced technologies	3	3
Spin-outs established	2	2
Academic-industry collaborations established	25	10
Commercialisation grants secured	4	6
Total	**54**	**42**

Figure 28 – Breakdown of grants reporting commercial activity by grant type



No. grants reporting commercial activities per €1m spend	
Project	0.8
Programme	0.3
Fellowship	0.7
Partnership	0.7
MRCG	1.4

Figure 29 – Breakdown of grants reporting commercial activity by strategic pillar area



No. grants reporting commercial activities per €1m spend	
Basic biomedical	0.9
Applied biomedical	0.9
Clinical research	0.5
Population Health	0.3
HSR	0.1

Examples of commercial activities

Activity TYPE	Details of Activity
Spin-out company	Dr Louise Kenny (CSA/2007/2) - We have an active program and a prototype algorithm built from several biomarkers and clinical risk features which we are pursuing regulatory approval for through a spin out company
Patent Filed	Dr Mark Tangney (RP/2007/75) - Patent filed: "Orally administered bacteria as vehicles for systemic delivery of agents" European Patent Application No. 09165716.3 Prof Ken McDonald (RP/2007/313) – Patent filed: "Biomarkers of cardiovascular disease including LRG." WO2011092219 Filing date 26.01.2011 Dr Louise Kenny (CSA/2007/2) – 2 patents filed: 1. "Detection of Risk of Pre-Eclampsia" US Provisional Application No: 61/288,465. Filing Date: 21 December 2009. Patent filed 21st Dec 2010 (PCT/EP2010/070446) 2. "Metabolomic profiling" US Provisional Application No: 61/414,243. Filing Dat:16 Nov 2010. Dr Sally-Ann Cryan (RP/2005/117) "Inhalable microparticles, and methods for the production thereof" European Patent Office 08012824.2 US Patent Office 61/081,084
Licenced technology	Dr Frank Lyons (HPF/2009/2) & Prof Fergal O'Brien PI - This fellowship carried out pre-clinical evaluation of the 'HydroxyColl' bone repair technology, which was subsequently in-licensed to SurgaColl Technologies, an RCSI spin-out campus company established to commercialize patented technologies developed in Prof O'Brien's laboratory
Invention Disclosures / Discussions with TTO	Prof Therese Kinsella (RP/2008/33)- Filed 2 invention disclosure forms: 1. "Interaction between the Human Thromboxane A2 Recepor and Angio-Associated Migratory Cell Protein: A new target for drug discovery and disease control, and/or biomarker for diagnostic applications" Filed by Prof. B. Therese Kinsella, to NOVA UCD Approx. March 2010. 2. "Interaction between the Human Thromboxane (TX) A2 Receptor and Protein Kinase C-related protein (PRK/PKN): Implications for the role of TXA2 in Prostate, Ovarian & Breast Cancer." Filed by Prof. B. Therese Kinsella, to NOVA UCD Approx. March 2010. Owing to the perceived pressure for publications by granting organizations, the decision was taken to publish our findings rather than protecting the data until sufficient material for patenting was in place.
Commercialisation grant	Prof Jochen Prehn (RP/2007/283) – Enterprise Ireland Technology Development Award "Systemic delivery of angiogenin protein for the treatment of Amyotrophic Lateral Sclerosis"

	This stream of work relates to research carried out by Prehn's group in collaboration with HRB-funded researchers Dr Matt Greenway and Prof Orla Hardiman going back to 2006, when they demonstrated an association between angiogenin mutations and amyotrophic lateral sclerosis (published in the journal *Nature Genetics*). The group subsequently demonstrated that angiogenin protein delivery may be beneficial in treating patients with newly diagnosed ALS. The underlying technology was protected through a series of intellectual property filings, recently granted. Shortly before grant of the patent, the RCSI TTO had identified a number of commercial partners before finally settling on Athena Diagnostics, based in Worcester, Massachusetts, as the partner of choice. Following negotiations a formal license agreement was executed which permitted the market launch of diagnostic kits in the US, Canadian and Japanese markets.

Section 4 - Conclusion

The analysis displayed in this report demonstrates a wide variety of outputs produced by HRB-funded research in terms of scientific output, capacity-building, health sector and economic benefits. When compared to the 2008/2009 analysis, the data shows that HRB-funded research completing in 2010/2011 led to more policy/practice outcomes and influences, produced slightly less publications per grant while maintaining an overall medium to high scientific impact, and produced an increased number of commercial activities and opportunities in the form of patents, licenses and industry collaborations.

The number and level of healthcare innovations (N=48), as well as the proportion of grants that led to influences on policy and practice (a quarter of all grants) is impressive and stands up very well when compared (provisionally) with data on similar outcomes captured by UK funders, such as the MRC and Wellcome Trust. Therefore, in terms of delivering on a key HRB objective of improving people's health and health care provision, HRB funded research appears to be having an impact.

Answering the value-for-money question is difficult and would be facilitated by the identification of appropriate metrics and perhaps targets, on a portfolio level. These metrics have to take into consideration the strategic objectives of particular funding schemes – for example, the main objective of fellowship schemes is to produce skilled researchers and build capacity for high-quality health research. Therefore, the ultimate success of fellowship schemes depends on the extent to which that key objective has been met and a review of outputs and outcomes produced through fellowships, while important, is a secondary consideration.

In terms of the strategic interpretation, the implication of the report findings, in the context of the HRB's Strategic Business Plan 2010-2014 and the shift away from basic biomedical research towards greater investment in clinical / population health sciences / health services research, is that over the coming years we may see a slight decrease in scientific 'productivity' (e.g. number of peer-reviewed publications per €million spend) and commercial impact (e.g. patents, industry collaborations). However, this will more than likely be offset by a concomitant increase in health sector outcomes such as development of innovations (e.g. interventions, therapies) and influences on policy and practice (e.g. clinical guidelines, policy briefs, advisory roles).

Next steps

In relation to next steps it will be important for the HRB to:

(i) Decide on an optimal timeframe and efficient mechanism for both capturing and reporting outputs and outcomes arising from HRB-funded research into the future – for example, annual capture of outputs and outcomes from all HRB-funded research (rather than just end-of-grant reports) would provide more comprehensive, up-to-date information for management;

(ii) Systematically track these outputs and outcomes into the future as they manifest into tangible health and economic impacts, to enable the HRB to promote the value and benefits of health research and to better understand the factors that influence research impact;

(iii) Compare the analysis described in this report with the analysis of the 2000-2009 portfolio impact assessment study, currently underway, in terms of the trends and variations in output productivity and outcome variety across the different funding modes and research areas;

(iv) Address the value-for-money question by identifying and examining appropriate metrics and strategic objectives linked to particular funding schemes.

Finally, a comparison with the analysis of outputs and outcomes arising from HRB grants completing in 2012 and 2013 will provide the first insight concerning the impact of the HRB Strategic Business Plan 2010-2014 and the new and revised funding initiatives introduced under that Strategy.

Appendix 1 – Summary of key outputs from 2010/2011 End-of-Grant reports by Grant Type

Impact Category / Key Indicator (No.)	Project Grants (106 grants)	Fellowship Awards (56 grants)	Programmatic Grants (12 grants)	MRCG Co-funded (7 grants)	Partnership Awards (9 grants)	Global Health Awards (6 grants)
Scientific outputs						
Mean no. peer-reviewed publications per grant	2.3	1.8	7.4	1.6	0.8	2.8
No. publications per €1 million spend	10	11	6	8	5	7
Average journal impact factor	5.1	5	4.9	4.6	4.2	3.8
Human capacity outputs						
Mean no. personnel per grant (total=280)	1.3	1	4.8	1.3	1	2.3
No. PhD degrees (total=72)	33	25	9	2	0	3
No. health professionals trained (total=82)	21	30	22	2	6	1
Influences on policy, practice and public						
% grants reporting policy/practice influences	17%	25%	58%	29%	33.3%	66.6%
No. grants reporting influences per €1m spend	1.1	2	2	3.4	5.5	3.5
% grants reporting public / patient outreach	33%	21%	66.6%	29%	66.6%	100%
Health sector innovations						
% grants that developed health innovations	19%	11%	75%	14%	56%	17%
No. health innovations developed (total=48)	20	6	15	1	5	1
No. innovations per €1 million spend	0.75	0.6	1	0.7	3.5	0.4
Economic and commercial activities						
% grants that leveraged additional grants (total=113 grants worth €35m)	41%	7%	50%	29%	56%	83%
No. invention disclosures and patents filed	10	2	2	0	1	0
No. licence agreements	2	1	0	0	0	0
No. spin-out companies established	0	1	1	0	0	0
No. industrial collaborations established	13	4	5	1	2	0

Appendix 2 – Summary of key outputs from 2010/2011 End-of-Grant reports by Strategic Pillar Area

Impact Category / Indicator	Clinical Research (37 grants)	Health Services Research (32 grants)	Population Health (15 grants)	Applied biomedical (83 grants)	Basic biomedical (29 grants)
Scientific outputs					
Mean no. peer-reviewed publications per grant	3	1.4	2.3	2.6	2.3
No. publications per €1 million spend	9.6	5	9	9	10.3
Average journal impact factor	4.4	2.5	3.4	5.3	6.5
Human capacity outputs					
Mean no. personnel funded per grant	1.7	1.9	1.5	1.2	1.2
No. PhD degrees	13	17	6	28	8
No. health professionals trained	34	28	9	11	0
Influences on policy, practice and public					
% grants reporting policy/practice influences	49%	47%	53%	8%	0%
No. grants reporting influences per €1m spend	3	4.5	4	0.5	0
% grants reporting public / patient outreach	49%	44%	13%	35%	21%
Health sector innovations					
% grants that developed health innovations	27%	22%	20%	21%	10%
No. health innovations developed	15	9	3	18	3
No. innovations per €1 million spend	1.3	1	0.8	0.75	0.5
Economic and commercial activities					
% grants that leveraged additional grants	38%	22%	33.3%	30%	41%
No. invention disclosures and patents filed	4	0	0	7	4
No. licence agreements	0	0	0	2	1
No. spin-out companies established	1	0	0	1	0
No. industrial collaborations established	5	1	1	15	3