EUROPEAN SCIENCE FOUNDATION

43 **Science Policy Briefing** • November 2011

Health Research Classification Systems – Current Approaches and Future Recommendations

Contents

Foreword

It has become increasingly apparent during many discussions held by the European Medical Research Councils (EMRC) that to make a meaningful analysis of activities carried out by research organisations in Europe it is necessary to have consistent approaches to the classification of research. So the initial proposal made by the Medical Research Council (UK) to produce a specific science policy briefing to assist research organisations to address this issue was well received by the EMRC at its meeting in Berlin in April 2010. In 2011 EMRC convened an expert group to examine approaches for the classification of health research portfolios. One reason that it was timely to focus on this issue was that the European Science Foundation (ESF) Member Organisations' (MO) Forum on Evaluation of Publicly Funded Research[1] had already begun to examine some of the challenges and possible solutions. This MO Forum has been actively examining barriers to the evaluation of research productivity, progress and quality across research organisations and across Europe, and provides a platform for the wider discussion of developments needed across all disciplines.

The work of this MO Forum is closely linked to furthering the ESF-European Heads of Research Councils (EUROHORCs) vision for a globally competitive European Research Area (ERA)[2], ensuring that these operational and practical discussions address issues that are central to a Europe-wide research strategy. It is more specifically aligned with action 6 of the ESF-EUROHORCs roadmap, namely 'Develop common approaches to *ex-post* evaluation of funding schemes and research programmes'. The evaluation work is aligned with other ESF MO Fora on Peer Review, Research Infrastructures and Indicators of Internationalisation[3]. All these are vital areas for greater coordination at a European level.

The European Union (EU) 27 nations represent just 7% of the world population and yet they have for around 30 years provided more than a third of the world's scientific output (as measured by journal articles)[4,5]. With the rise in scientific output of emerging economies such as China, India and Brazil, which together represent 40% of the world population, Europe has to look to achieve better coordination, efficiency and effectiveness to safeguard its research strengths and continue to compete successfully – one of the topics of the recently published EMRC White Paper II[6].

However there are significant challenges to realising a globally competitive ERA. Although the EU27 nations represent a population similar to that of the US (which has approximately 5% of the world population), the task of understanding research activity across such a number of autonomous member countries, each with complex funding arrangements, is clearly more difficult.

In this briefing, EMRC highlights the substantial benefits that could be realised in Europe if common approaches for the analysis and tracking of the details of research inputs (and outputs) over time are developed, and this information widely shared. We are pleased to note that in the specific area of health research there already exist approaches to research classification that are being adopted (such as the UK Health Research Classification System) and examples of initiatives that have helped coordination on an international scale (for example the International Cancer Research Partnership). The ability to compare and contrast the success of different policy interventions over time will equip research organisations with the evidence they need for advocacy, accountability and improved strategy development in future. This is summarised in the recommendations at the end of this report.

Finally, we would like to acknowledge and thank the Science Policy Briefing expert group and the EMRC staff for their excellent work.

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Cover
Scientist reaching for test tube – Photographer: Adam Gault – Source: Dijitalimaj

1. ESF MO Forum on Evaluation of Publicly Funded Research: http://www.esf.org/activities/mo-fora/evaluation-of-publicly-funded-research.html (accessed Nov-7, 2011)
2. 'EUROHORCs and ESF Vision on a Globally Competitive ERA and their Road Map for Actions', July 2009: http://www.eurohorcs.org/E/news/2009/Pages/_xc_news_090713_RoadMap.aspx (accessed Nov-7, 2011)
3. ESF MO Fora: http://www.esf.org/activities/mo-fora (accessed Nov-7, 2011)
4. Larsen PO, Maye I and von Ins M. Scientific Output and Impact: Relative Positions of China, Europe, India, Japan and the USA, 2008. In: Fourth International Conference on Webometrics, Informetrics and Scientometrics and Ninth COLLNET Meeting, Humboldt-Universität zu Berlin, Institute for Library and Information Science (IBI), Berlin, July 28-August 1, 2008. pp. 1-9. Available from: http://www.collnet.de/Berlin-2008/LarsenWIS2008soa.pdf (accessed Nov-7, 2011)
5. EMRC White Paper II 'A Stronger Biomedical Research for a Better European Future', September 2011. ISBN: 978-2-918428-35-0. Available from: http://www.esf.org/emrc (accessed Nov-7, 2011)
6. EMRC White Paper II 'A Stronger Biomedical Research for a Better European Future', September 2011. ISBN: 978-2-918428-35-0. Available from: http://www.esf.org/emrc (accessed Nov-7, 2011)

Executive summary

This Science Policy Briefing summarises the reasons why research organisations invest time and effort in classifying their research portfolios and the benefit that this work brings to them. Classification supports the monitoring of changes in portfolios (consistent reporting over time) and can help ensure that an organisation's strategy effectively addresses gaps and opportunities. Classification systems may also be used to organise peer review processes, facilitate efficient searching of portfolio information and support regular analysis of the portfolio. The benefits of successful classification approaches include improved communication, identification of opportunities, ability to compare activity with other research organisations, support for partnership working and increased efficiency of operational processes.

The main systems that exist for categorising health research in use across research organisations internationally are summarised. One system designed specifically for health research (the Health Research Classification System, HRCS) is in use in a number of research organisations across Europe, and the benefits that having a "common language" for analysis and comparison of portfolio information are emphasised. The fact that most research organisations operate their own bespoke approaches to categorisation, that organisational operations are often highly dependent upon these systems, and that these categorisation approaches may be used across a broader set of disciplines than just health research is acknowledged.

Key limitations and challenges to implementing a standard approach to classification are identified. These include the fact that organisations with a complex portfolio are unlikely to be able to answer all questions about the evolution of their portfolio with a single categorisation approach. There are choices for research organisations to be made in implementing a classification approach, for example whether to categorise all proposals received or only those awarded and whether to train internal staff to categorise awards or outsource this work. Alternatively research organisations may consider evaluating and introducing automated processes for this task. These choices are of course driven by the costs and benefits gained by the organisation from making these changes to its strategy development and administrative processes. The key characteristics of a successful classification approach are summarised as simple (complex systems are less likely to be routinely and widely used so less likely to realise their full benefit), relevant (classification approaches have to be fit for purpose), consistent and standardised (approaches should allow comparisons over time) as well as multi-dimensional and flexible (approaches have to be able to answer a range of evaluation questions).

The recommendations drawn as a result of this review of classification systems are:

1. Use of the HRCS is encouraged as the leading approach for comparison and joint analysis of specifically *health* research portfolio information.
2. Methodological developments are needed to reduce the cost of classification and increase flexibility.
3. Coordination of a common approach is needed across organisations at the national, European and international level.

Introduction

Organisations that perform and fund research[7] have to be able to accurately account for and be transparent about how their funds are deployed. Sponsors, governments and the public want to know which areas of research are receiving support and the level of investment in each area. It is also increasingly important for research organisations to be able to combine and compare information about their research portfolios with other research organisations in order to be able to benchmark their performance and collaborate in the support of research and development (R&D) internationally.

Research classification is the fundamental first step to understanding resource flows into R&D. The following considerations and strategies are also valid (and must be valid) for other organisations which have research plans among their activities. These principally include universities but also industry, foundations and so forth. However portfolio information from the private sector is unlikely to be available so there is usually a knowledge gap when analysing portfolios at a national and international level. Thus classifying only public and charity-funded research represents an important limitation.

Classification sorts data about research funding into discrete categories. Sets of awards with closely related themes, disease focus, or other characteristics are grouped into similar categories. Many classification systems follow a structure which branches from high-level more generalised categories to more specific sub-catego-

7. In this document, "research organisations" will refer to research performing and research funding organisations.

ries, allowing increasingly more detailed analysis.

Maintaining a consistent approach to categorisation allows changes in research portfolios to be tracked over time. The ability to sort and analyse research portfolios in this way is considered an important issue underpinning the work of medical research funding agencies in Europe.

Organisations also want to strengthen their capability to evaluate the success of research projects, programmes and initiatives. Research organisations are capturing detailed information about the progress, productivity and quality of research output, and usually this information is referenced back to decisions made to invest in particular research projects or support particular researchers. The ability to categorise projects by subject area and type can provide insight into which areas, or sub-disciplines, of research are more productive or progressing more rapidly.

High-quality approaches for research classification help research organisations with one or more of the following objectives:

- **Monitor and develop organisational strategy**
  Consistently report investment over time by scientific area and/or type of research, in order to understand progress with organisational strategies. This might lead to the development of new funding initiatives to address gaps and opportunities.
- **Organise peer review process**
  Assign relevant reviewers and allocate applications to research boards.
- **Produce research portfolio statistics**
  Cover statistical needs and provide information at the national and international level. Example: funding ranking profiles produced by the Deutsche Forschungsgemeinschaft (DFG; see Box 3).
- **Structure research information systems**
  Support search function in online databases to get information about funded projects in a specific scientific area.

Research efforts are global, and increasingly research organisations want to coordinate their funding with other organisations, to jointly fund research and benchmark their progress internationally. Collaborating organisations need effective ways to look at gaps and opportunities to better identify where there is scope for joint action. The use of approaches for the classification of research portfolios that are common across funding organisations is likely to assist with such ambition. The connection between sound approaches for the classification of research portfolios and work to create a globally competitive European Research Area (ERA) has been recently highlighted by the ESF Member Organisations' (MO) Forum on Evaluation of Publicly Funded Research[8]. This forum is composed of 33 ESF MOs and seven observers and was established following the need to exchange information on evaluation practices and practical approaches within MOs. As the sole dedicated platform for European research organisations it provides a continuous forum to exchange information and work together on common projects and it will finalise its activities during 2012. Work within the ESF MO Forum has identified that many European research organisations are reviewing their approaches for classifying their research portfolios. Work has been performed to gather examples of best practice and consider commonalities and differences in approach across Europe. A working document entitled 'The classification of research portfolios' was published in May 2011 summarising the MO Forum discussions[9].

Convergence between funding agencies regarding the approaches used to classify research portfolios will assist the analysis of strengths and weaknesses and the identification of opportunities, particularly for joint action.

In summary, the benefits of common approaches to the classification of research portfolios include:

- **Communication**
  Communicating research organisation activity in a standardised way to sponsors, governments and the public.
- **Identification of new opportunities**
  Identifying gaps and opportunities and encouraging appropriate prioritisation of research funding.
- **Comparable analysis**
  Obtaining comparable analyses of research for benchmarking progress, productivity and quality of research output and providing this evidence base for future strategy development.
- **Collaboration**
  Helping to identify potential partners, triggering new collaborations and avoiding duplication.
- **Efficiency**
  Helping to streamline operational processes for peer review, selection of reviewers and recruitment of scientists.

8. ESF MO Forum on Evaluation of Publicly Funded Research: http://www.esf.org/activities/mo-fora/evaluation-of-publicly-funded-research.html (accessed Nov-7, 2011)
9. Working Document 'The classification of research portfolios': http://www.esf.org/activities/mo-fora/evaluation-of-publicly-funded-research.html (accessed Nov-7, 2011)

While the EMRC expert group that has produced this briefing focused on the needs of organisations that fund *health* research (which accounts for a substantial proportion of investment in R&D), the issues are of interest to other disciplines. In addition many funders support research across other/all scientific disciplines.

The developments highlighted in this report should be progressed as soon as it is published so that organisations can begin to benefit from enhanced capability to benchmark their investments and coordinate investment in research as quickly as possible. A workshop will take place by the end of 2011 to discuss the implementation of the recommendations and define the 2012 workplan. This timeline could prove essential in the current context of the Horizon 2020 and ERA discussions. The ESF MO Forum on Evaluation of Publicly Funded Research is an appropriate route to continue to encourage European partners to share expertise.

Classification systems used in health research

In 2010 the ESF MO Forum on Peer Review[10] that includes over 30 European research organisations from 23 countries ran workshops and undertook a comprehensive survey of the peer review systems and practices used by research organisations as well as councils, private foundations and charities[11]. The results served to identify good practices across Europe on the evaluation of grant applications for individual and collaborative research projects, developing 'The European Peer Review Guide'[12]. It was clear from this work where organisations were asked how they categorise their research portfolios that many approaches have elements in common but there is no unified approach across Europe. Of concern is that some organisations reported that they had no system at all to consistently categorise their research portfolios[13].

The EMRC expert group and ESF MO Forum on Evaluation of Publicly Funded Research highlighted several approaches which are relevant to the categorisation of health research portfolios. It was noted that while the focus of the EMRC expert group was to examine approaches relevant in particular to health research, there was much to learn from approaches in other disciplines. Advances in medicine often arise as the result of multi-disciplinary endeavours, and many funding agencies have a wider remit than *health* research. There is therefore merit in considering approaches which may be applicable across a wider range of disciplines.

OECD Frascati Manual

The Organisation for Economic Co-operation and Development (OECD) Frascati Manual[14] provides a framework for the routine collection of data on R&D to track expenditure across all OECD countries. It is not designed to take detailed strategic decisions regarding individual disciplines as it is not sufficiently fine-grained for this. With just a few codes applied to health research it lacks the level of detail required to analyse the proportion of research devoted to particular disease areas (health categories), and it is necessary to use data from other sources to derive a figure for health-related R&D. However the Frascati Manual is the most widely used R&D classification scheme internationally so it would be advantageous to be able to aggregate categories in discipline-specific classification systems and map these to the Frascati system.

The Frascati Manual is revised occasionally, for example the Field Of Science and Technology (FOS) classification was updated in 2007 in order to reflect the latest changes in emerging technology fields such as biotechnology or nanotechnology[15].

The Australian and New Zealand Standard Research Classification (ANZSRC)

The ANZSRC[16] is jointly produced by the Australian Bureau of Statistics (ABS) and Statistics New Zealand (Statistics NZ) and is also based upon the OECD Frascati Manual.

10. ESF MO Forum on Peer Review: http://www.esf.org/activities/mo-fora/peer-review.html (accessed Nov-7, 2011)
11. 'ESF Survey Analysis Report on Peer Review Practices', March 2011. Available from: http://www.esf.org/activities/mo-fora/peer-review.html (accessed Nov-7, 2011)
12. 'European Peer Review Guide', March 2011. ISBN: 978-2-918428-34-3. Available from: http://www.esf.org/activities/mo-fora/peer-review.html (accessed Nov-7, 2011)
13. See also 'Joint Programming in research 2008-2010 and beyond', Report of the High-Level Group on Joint Programming to the Council, Annex II on 'Voluntary guidelines on framework conditions for joint programming in research 2010' discussing peer review, ERAC-GPC 1311/10, November 2010. Available from: http://ec.europa.eu/research/era/docs/en/joint-programming-in-research-2008-2010-and-beyond--report-of-the-high-level-group-on-joint-programming-to-the-council.pdf#view=fit&pagemode=none (accessed Nov-7, 2011)
14. OECD Frascati Manual: http://www.oecd.org/document/6/0,3343,en_2649_34451_33828550_1_1_1_1,00.html (accessed Nov-7, 2011)
15. OECD report, DSTI/EAS/STP/NESTI(2006)19, 26 February 2007. 'Revised Field Of Science And Technology (FOS) Classification in the Frascati Manual'. Available from: www.uis.unesco.org/ScienceTechnology/Documents/38235147.pdf (accessed Nov-7, 2011)
16. ANZSRC: http://www.abs.gov.au/AUSSTATS/abs@.nsf/Lookup/1297.0Main+Features12008 (accessed Nov-7, 2011)

The Australian research classification scheme has been in use for several decades and is updated approximately every ten years to take account of new and changing fields. ANZSRC 2008 replaced the previous Australian Standard Research Classification (ASRC) 1998 system.

ANZSRC is the collective name for a set of three related classifications developed for use in the measurement and analysis of R&D, and its hierarchical structure is very useful for reporting purposes. The use of the three constituent classifications in the ANZSRC ensures that collected R&D statistics are useful to governments, educational institutions, international organisations, scientific, professional or business organisations, business enterprises, community groups and private individuals in Australia and New Zealand.

The ABS provides correspondence tables to compare the ANZSRC system with the OECD's FOS 2007 classification and the Eurostat's Nomenclature for the Analysis and Comparison of Scientific Programmes and Budgets (NABS) 2007 classification.[17]

The three constituent classifications included in the ANZSRC are:

- **Type of Activity (ToA)**
  Type of research effort, namely, pure basic research, strategic basic research, applied research and experimental development. The National Health and Medical Research Council (NHMRC)'s Broad Research Area classification (Basic Science, Clinical Medicine and Science, Health Services Research, Public Health) is somewhat similar to the ToA coding, although specific to health and medical research.
- **Field of Research (FoR)**[18]
  Major fields of research investigated by national research institutions and organisations as well as emerging areas of study. In this respect the methodology used in R&D is considered. FoR is relatively widely employed in Australia, for instance by the Australian Research Council (ARC), the NHMRC, other funding agencies and governmental departments. As FoR is largely used in the Excellence in Research for Australia initiative developed by the ARC, the Australian research community is strongly interested in this system and would like to review it in the future.
- **Socio-Economic Objective (SEO)**
  Purpose or outcome of R&D as perceived by the data provider (researcher). It consists of discrete economic, social, technological or scientific domains for identifying the principal purposes of R&D. SEO is often used by funding agencies but often appears to be not very well understood in health and medical research which is captured under a small number of SEO categories.

17. Correspondence tables: http://www.abs.gov.au/AUSSTATS/abs@.nsf/DetailsPage/1297.02008?OpenDocument#Data (accessed Nov-7, 2011)
18. The FoR is a hierarchical classification with three levels, namely Divisions (2 digits), Groups (4 digits) and Fields (6 digits). Each level is identified by a unique number. Each Division is based on a broad discipline. Groups within each Division are those which share the same broad methodology, techniques and/or perspective as others in the Division. Each Group is a collection of related FoR. Groups and FoR are categorised to the Divisions sharing the same methodology rather than the Division they support.

US National Institutes of Health (NIH) Research, Condition and Disease Categorization (RCDC) system

Historically, each NIH institute independently assigned grant funding information to research categories defined within their institute. With 27 NIH institutes and centres, varied interpretations led to inconsistent reporting of research category funding in areas of extramural and intramural research, or R&D. At the request of Congress, the NIH implemented a process in 2008 to provide better consistency and transparency in this reporting. This process, called "RCDC system"[19], combines sophisticated text data mining (i.e. categorising and clustering, using words and multiword phrases) with NIH-wide definitions applied to match projects to the 229 categories used to report to Congress. Categories can be a research area, a disease or a condition. A category definition is a series of terms or concepts that are drawn from the RCDC thesaurus. The research category levels represent the NIH's best estimates based on the category definitions. The RCDC system is the backbone of reporting by NIH on the publicly accessible and searchable website titled 'NIH Research Portfolio Online Reporting Tools' (RePORT) as well as 'RePORT Expenditures and Results' (RePORTER)[20]. The RePORTER website includes grants allocated to both US-based principal investigators and those based in foreign sites. It provides a range of data such as title or history of projects, expenditures as well as publications as project output.

19. RCDC: http://report.nih.gov/rcdc/ and http://report.nih.gov/rcdc/categories/ (accessed Nov-7, 2011)
20. RePORTER: http://projectreporter.nih.gov/reporter.cfm (accessed Nov-7, 2011)

Medical Subject Headings (MeSH)

Bibliographic databases and repositories of publications operate systems for the categorisation of research articles in order that they can be searched for papers relating to particular subjects. The Thomson Reuters Web of Knowledge® (formerly referred to as ISI Web of Science®)[21] and Elsevier's SciVal® publications databases[22] both use journal subject categories to sort and classify articles. PubMed[23], PubMed Central[24] and UK PubMed Central[25] use Medical Subject Headings (MeSH®), the thesaurus produced by the US National Library of Medicine (NLM), to categorise publications produced by research.

MeSH®[26] is the NLM's controlled vocabulary thesaurus and is one of the thesauri that are consulted to obtain a category definition in RCDC. It consists of sets of terms naming descriptors in a hierarchical structure that permits searching at various levels of specificity. MeSH® descriptors are arranged in both an alphabetic and a hierarchical structure. There are 26,142 descriptors in 2011 MeSH®, plus over 177,000 entry terms that assist in finding the most appropriate MeSH® heading, e.g. "Vitamin C" is an entry term to "Ascorbic Acid." The MeSH® thesaurus is used by NLM for indexing articles from 5,400 of the world's leading biomedical journals for the MEDLINE®/PubMed database. It is also employed for the NLM-produced database that includes cataloguing of books, documents and audiovisuals acquired by the Library. MeSH® is continually updated with new terms as these appear in the literature.

The Common Scientific Outline (CSO)

The CSO system[27] was developed by the US National Cancer Institute (NCI) in the late 1990s. The CSO was developed via workshops in which scientists, panel members, applicants and programme staff categorised abstracts and then evaluated the validity of the coding. The CSO is now directed and managed by a partnership of research organisations that runs an initiative entitled 'International Cancer Research Partnership' (ICRP)[28]. The partner organisations include the UK National Cancer Research Institute and the Canadian Cancer Research Alliance (CCRA), ten individual funders from the USA including NCI/NIH and two other European funders, totaling 49 funding organisations worldwide. The ICRP partner organisations meet annually and via teleconference periodically throughout the year to share information and review the implementation of the CSO in their organisations (see Box 1).

Box 1. The International Cancer Research Partnership (ICRP) – Adding Value to Cancer Research

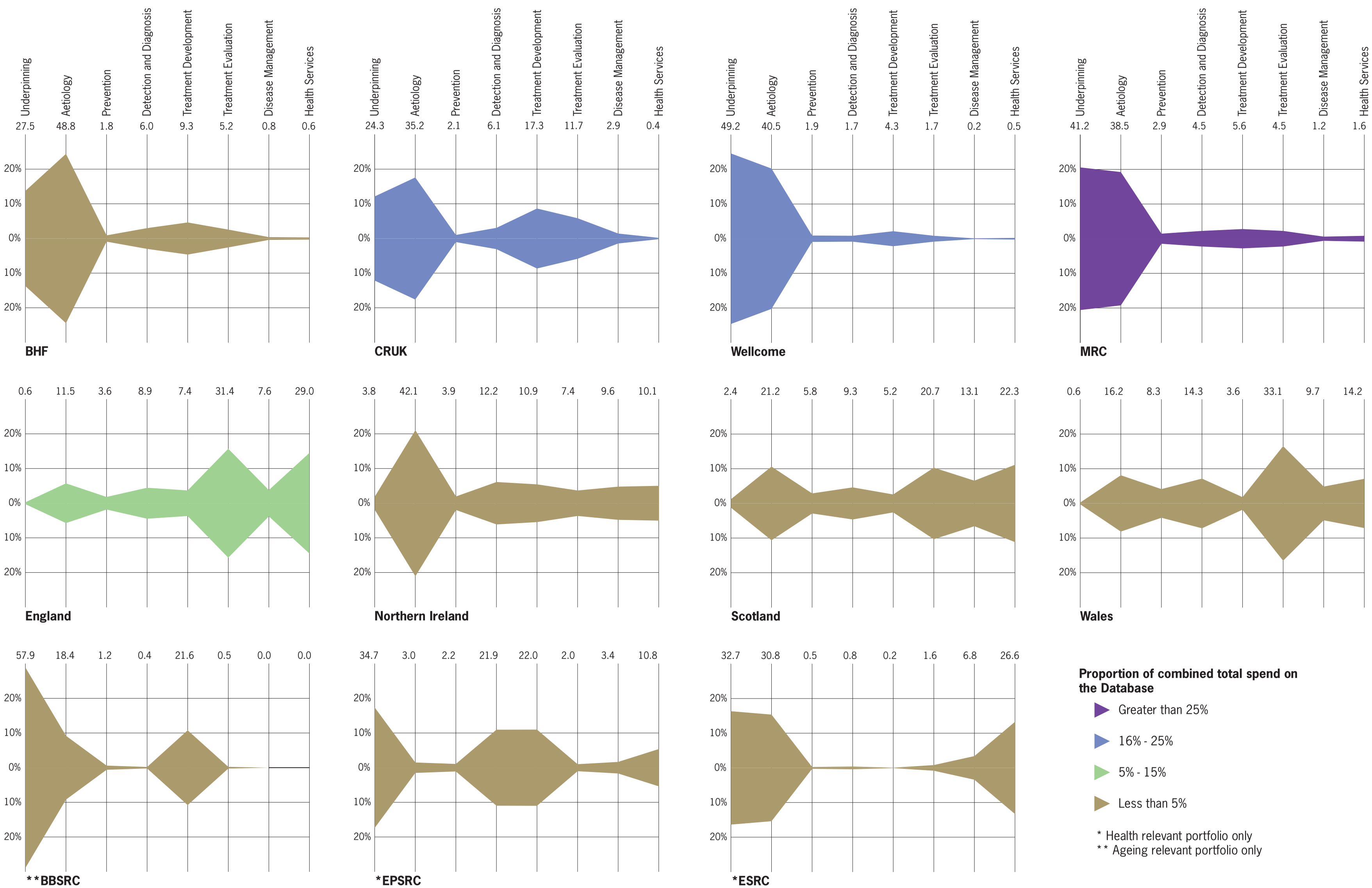
Since the formation of ICRP in September 2000, contributing organisations have focused on implementing the Common Scientific Outline (CSO) to meet the needs of all member organisations. The CSO is now being used in many ways to inform internal and joint policies and it provides an internationally regulated framework that ensures comparability, consistency and accuracy of coding.

The ICRP's mission is to add value to cancer research efforts internationally by fostering collaboration and strategic coordination between cancer research organisations. As well as joint analysis of cancer research activity using the CSO, the ICRP facilitates networking to improve collaboration and coordination and the sharing of resources, such as evaluation tools.

Funding has recently been obtained via an ERA-NET award for translational research (TRANSCAN)[29], for analysis of the European cancer research funding portfolio at the grant level using the ICRP's CSO classification system. 25 cancer and medical research funding organisations are involved in total. The plan is to create a coded European analysis of cancer research awards.

The ICRP public website allows users to search for cancer research awards using defined criteria and is a valuable tool for researchers to identify potential collaborators worldwide. The ICRP website allows organisations to conduct their own analyses of the international portfolio, giving partners an international perspective to help inform strategic planning. In addition the site provides online networking tools for partner organisations via a website forum.

21. Web of Knowledge®: http://wokinfo.com/products_tools/multidisciplinary/webofscience/ (accessed Nov-7, 2011)
22. SciVal®: http://www.scival.com/ (accessed Nov-7, 2011)
23. PubMed: http://www.ncbi.nlm.nih.gov/pubmed/ (accessed Nov-7, 2011)
24. PubMed Central: http://www.ncbi.nlm.nih.gov/pmc/ (accessed Nov-7, 2011)
25. UK PubMed Central: http://ukpmc.ac.uk/ (accessed Nov-7, 2011)
26. MeSH®: http://www.nlm.nih.gov/pubs/factsheets/mesh.html (accessed Nov-7, 2011)
27. CSO: https://www.icrpartnership.org/CSO.cfm (accessed Nov-7, 2011)
28. ICRP: http://www.cancerportfolio.org/cso.jsp (accessed Nov-7, 2011)
29. TRANSCAN: http://ec.europa.eu/research/health/medical-research/cancer/fp7-projects/transcan_en.html (accessed Nov-7, 2011)



Data excludes R&D support for NHS providers funded by the UK Health Departments, core support costs (e.g. for the Wellcome Trust Sanger Institute) and research taking place outside the UK.

Figure 1.
Profile of organisation spend by research activity. Kite diagrams showing the portfolios of 11 participating organisations in the UK (extracted from the UKCRC *UK Health Research Analysis* report*). See list of abbreviations for acronyms.
* UKCRC 'UK Health Research Analysis' report (2006): http://www.ukcrc.org/researchcoordination/healthresearchanalysis/ukanalysis/ (accessed Nov-7, 2011)

UK Health Research Classification System (HRCS)

The HRCS[30] is a system for classifying and analysing biomedical and health research funding. Its role is to facilitate research management by answering strategic questions about investment.

Based on the CSO in use by the ICRP, the HRCS is a two-dimensional framework. Codes from both HRCS dimensions are applied when classifying:

- **Health Categories**
  Used to classify the type of health or disease being studied.
  There are 21 categories encompassing all diseases, conditions and areas of health.
- **Research Activity Codes**
  Used to classify the type of research activity being undertaken (from basic to applied).
  There are 48 codes divided into eight groups:
  1. Underpinning
  2. Aetiology
  3. Prevention
  4. Detection and Diagnosis
  5. Treatment Development
  6. Treatment Evaluation
  7. Disease Management
  8. Health Services

The strategic aim of coding using the HRCS is to capture the main objective of the research taking place during the lifetime of the award and not the background or future potential downstream applications of the research (see Figure 1 and Box 2). HRCS provides a broad overview of the centre of gravity of a set of research awards.

Defined percentages are assigned to all HRCS codes – which means that the associated funding is analysed exactly with no double counting. In order to classify research projects with the HRCS a short scientific summary of the proposed work is required, usually available within application forms.

Given that the ICRP has successfully provided cancer research organisations with the ability to monitor and compare changes in cancer research portfolios internationally, there is the potential for the HRCS to also achieve this across all health research. The CSO has been in use as a tool for analysing multiple research organisations' portfolios for more than ten years so learning from this initiative should allow the HRCS to be rapidly and widely implemented.

30. HRCS: www.hrcsonline.net (accessed Nov-7, 2011)

Box 2. Use of the HRCS in strategic coordination between funding agencies in the UK

The HRCS underpinned two important reports issued by the UK Clinical Research Collaboration (UKCRC) which together provided a comprehensive overview of non-commercial health research funding in the UK in 2004-2005.

The *UK Health Research Analysis* report, published in 2006, was the first ever national analysis of UK health research. It provided an overview of all types of health research activity across all areas of health and disease in the UK, funded by the 11 largest governmental and charity health-related research funders. The HRCS allowed meaningful comparisons to be made across the different funders' research portfolios. The report includes:

- A breakdown of spending on all types of health research (from basic to clinical) across all areas of health and disease.
- Details of the distribution of funding within individual areas of health and disease.
- The geographical spread of health research investment across the UK.

Subsequently the HRCS was used to analyse the funding activities of 29 medium and smaller sized members of the Association of Medical Research Charities (AMRC) in the UKCRC report *From Donation to Innovation*, published in 2007.

The two reports have been disseminated widely in the UK and had a major impact, providing the basis for high-level strategy discussions and informing a number of joint funding initiatives:

- Strengthening the evidence base for strategic discussions by research funders and importantly *between* funding agencies.
- Supporting a clear view from the government about the priorities for medical research.
- Stimulating a number of new joint funding initiatives between funding agencies to address particular gaps, opportunities and areas that need capacity building:
  - National Prevention Research Initiative (more than £30m [34M€] committed via four phases from 16 funders).
  - Public Health Initiative (£20m [22.6M€] to fund five centres of excellence from eight funders).

– Translational Infections Research Initiative (£16.5m [18.7M€] for new grants from seven funders).
– UK brain banking strategy (appointment of national director and greater coordination of activity).

The main public and charitable funding agencies for health research in the UK plan a new analysis of health research using the HRCS, based on expenditure in 2009-2010, to be published in 2011.

G-Finder survey

The George Institute for International Health operates a database of research in neglected diseases supported by the Bill and Melinda Gates Foundation (G-Finder)[31]. This work, endorsed by the World Health Organization (WHO), specifically tracks research aimed at treating and preventing diseases from HIV/AIDS, malaria and tuberculosis to leprosy and typhoid fever. The survey to collect information on funding of this type of research is applied to over 130 organisations in 43 countries. This information is essential to the debate over the financial support of research on neglected diseases.

Research organisations' specific systems

There are many examples of successful internal classification systems, e.g. the DFG's outlined in Box 3.

The Flanders Research Information Space (FRIS)[32] is a database of Flemish research projects which is notable for ordering all data following the Common European Research Information Format (CERIF) data model. While CERIF is not itself a categorisation approach, it is a European standard which aims to enable data exchange on an international level and therefore important to consider when implementing classification approaches. CERIF is curated by the European Organisation for International Research Information (euroCRIS)[33].

Box 3. The DFG's classification system

The DFG uses a classification which covers all disciplines. The system includes 203 subject areas in 48 review boards grouped to 14 high-level research areas and ultimately four main scientific disciplines (humanities and social sciences, life sciences, natural sciences and engineering). Codes in medicine are mainly covered by subject areas related to review boards 201 (foundations of biology and medicine), 204 (microbiology, virology and immunology), 205 (medicine) and 206 (neurosciences). Within these four review boards DFG-funded projects are classified on the basis of 53 subject areas[34].

The classification is organised in the same way as the review board system of the DFG is structured. Review board members are elected every four years by the scientific community (mainly scientists from universities in Germany) and ensure the overall quality of the DFG's peer review process. From the outset of the application process project proposals are assigned to an appropriate review board.

The DFG's classification system is furthermore used to generate statistics and to structure online information systems. The DFG's system GEPRIS (German Project Information System[35]) provides users with the ability to retrieve information on DFG-funded projects by means of the above-mentioned disciplinary classification, e.g. "Internal Medicine – Rheumatology" or "Radiology, Nuclear Medicine, Radiotherapy". Additionally it offers the possibility to search for projects by keywords within project abstracts.

A more advanced statistical use of the disciplinary classification system is described in the publication 'Funding Ranking', which is released every third year[36]. Besides statistics on research expenditure in each review board area, the classification is used for the analysis of the overall "research profile" of universities. The "profile analyses" show the particular disciplinary mix of each German university defined by the sum of money these universities received in each of the fields being covered by the classification (see Figure 2).

31. G-Finder: https://studies.thegeorgeinstitute.org/g-finder/ (accessed Nov-7, 2011)
32. FRIS: http://www.researchportal.be/en/about.html (accessed Nov-7, 2011)
33. euroCRIS: http://www.eurocris.org (accessed Nov-7, 2011)
34. DFG's classification: http://www.dfg.de/download/pdf/dfg_im_profil/gremien/fachkollegien/dfg_fachsystematik_en_08_11.pdf (accessed Nov-7, 2011)
35. GEPRIS: http://www.dfg.de/gepris (accessed Nov-7, 2011)
36. DFG's 'Funding Ranking' report: www.dfg.de/en/ranking (accessed Nov-7, 2011)

Funding profiles of HEIs: Subject map based on DFG awards in the life sciences

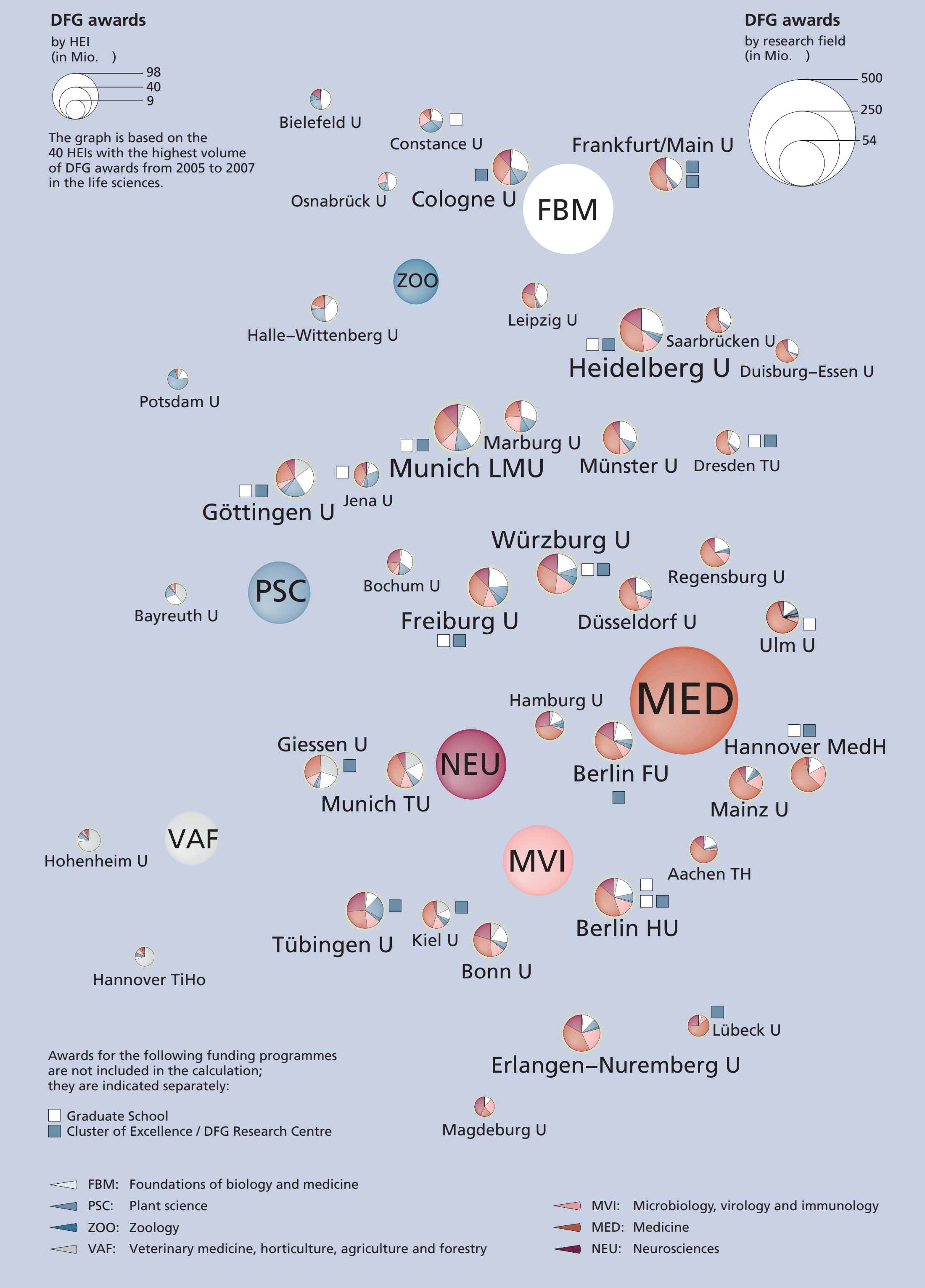


Figure 2.
Funding profiles of the German Higher Education Institutions (HEIs) with the highest funding volumes in the research fields of life sciences, according to their priorities in terms of financial support by the DFG. For instance, Munich, Giessen and Hamburg universities have received the highest level of funding in Neurosciences (NEU).

Key limitations and challenges to introducing a portfolio classification approach

It is important to note that approaches for classifying research portfolios are focused on categorising expenditure on scientific projects and programmes, not auditing the entire expenditure of an organisation. Expenditure on research infrastructures (see Box 4 below) and administrative support to research have to be accounted for separately. Other key limitations and challenges include:

1. No single ideal classification

The range of questions that research organisations are expected to address will mean that no single classification system is likely to be ideal for all eventualities. Questions regarding detailed areas of science, or entirely new fields of research (e.g. nanotoxicology, stratified medicine), require highly granular classification systems that are revised regularly. Policy questions such as trends in capacity building for translational research require categorisation terms which are high-level and stable over long periods of time. Some larger research organisations operate several classification systems, each optimised for a particular purpose.

2. Differences in operational processes

It is important to implement a suitable workflow for the classification of research. Questions might include: whether to classify all applications received or just proposals that are successfully funded; who should carry out classification; and what material should be used to determine appropriate categories.

The Swedish Research Council has conducted an analysis of success rates across health research using the HRCS which has informed their prioritisation of research funding. This analysis relied upon the ability to categorise all proposals the Swedish Research Council received, not just those it funded[37].

The Research Council of Norway, again using the HRCS, has examined the feasibility and consistency of classification when different groups are given the task of coding awards. Comparisons were made between researchers, programme board members, research council staff and external contractors[38].

With respect to the material that classification is based upon, the scientific abstract included in proposals is the one most commonly used. The abstract has to contain sufficient detail and be clear enough about the proposed research for it to be helpful in consistent categorisation.

3. Overlaps between scientific areas and/or interdisciplinary research

Proposals are rarely exclusively about a single research issue and may span a number of disciplinary areas and/or include research at different developmental stages. Classification approaches need rules that guide the categorisation of research which can be referred to by those carrying out the classification and which ensure consistent use of the system. Categories may be exclusive and non-overlapping, with proposals sorted into one category or another. Alternatively, proposals may relate to a number of categories and fully count toward each, providing an overlapping picture of research. More commonly research is apportioned to a number of categories but with no double counting.

4. Various research information systems in use

Classification systems are used to support search functions in online databases to retrieve information about funded projects in specific scientific areas. The German research database service GEPRIS[39], for instance, uses different classification systems in order to enable a more efficient search for projects and scientists as well as scientific infrastructures. In addition, information systems on research institutes as for example the German Research Explorer[40] also use classification systems to provide search results by combining different scientific fields as well as geographic criteria. The Research Explorer covers over 17,000 German research institutes with continually updated postal and web addresses.

In general, there are many different classification systems which may lead to variable search results subject to the classification that structures the scanned database. A common classification system between European funding organisations is the requirement for building up a data model (e.g. CERIF) for a comprehensive European Research Information System.

37. See also Working Document 'The classification of research portfolios': http://www.esf.org/activities/mo-fora/evaluation-of-publicly-funded-research.html (accessed Nov-7, 2011)
38. See also same Working Document as above.

39. GEPRIS: http://www.dfg.de/gepris (accessed Nov-7, 2011)
40. German Research Explorer: http://research-explorer.dfg.de (accessed Nov-7, 2011)

5. Training and guidance

For systems that are to be widely used there needs to be documentation suitable for the training and guidance of staff that categorise research awards. Ideally there should be a "community of practice" which captures learning about the classification approach, updates guidance documentation and ensures that this is widely shared. If classification systems are to be international then there is an issue regarding how this "community" can be supported.

Increasing awareness of data systems for classifications and promoting applications of how these are/can be utilised are vital to a collaborative and efficient process for data analysis in the case of inter- and intra-agency coordination.

6. Human and technical resources

The overhead costs of running a system for classifying research portfolios are an important consideration. These costs need to be balanced by the benefit of being able to respond to questions and improvements to strategy development and partnership working. These benefits are often difficult to quantify. There is also a lack of systematic work that examines the most efficient approaches for classifying research portfolios. Considerations include who carried out the work to categorise awards (researchers themselves [researcher-led], research organisation staff [internal], review panel members, scientists involved in the management of research programmes) and whether this work can be outsourced and/or partly automated.

Developing global capacity for health research informatics is crucial and health research classification systems are vital to institute in emerging economies. In countries such as India and China, there is increased investment in health research and a very high level of expertise in informational sciences. Collaborations to archive research investments and scientific outputs in a systematic manner are important in building research and analytic capacity in these countries.

7. Unit of analysis

As with planning any analysis, organisations will need to carefully consider whether all types of awards are included in their approach for classifying research. Awards may vary substantially in the funding they represent. Larger awards for consortia, networks or programmes may need to be disaggregated into themes and categorised. The work to categorise small awards, for example studentships, may be considered inefficient, although a large number of these awards may collectively represent a significant investment. In this case approaches to aggregate awards and estimate the relative proportion of support under different categories may be used.

Investments in research infrastructures cannot be classified in the same way as research projects and programmes (see Box 4).

> **Box 4. Research infrastructures**
>
> Significant investments are made by funding agencies in infrastructures and facilities which underpin R&D[41]. It is not practical to try to apportion investment in e.g. new buildings, when a large number of research projects will benefit to varying degrees from this support. Usually only investments that directly pay for specific research, for which there will be a scientific summary, set of objectives or abstract that can be used as the basis for coding, are classified. Support for research infrastructures then has to be accounted for separately.

8. Quality assurance/quality control

A key issue in classification is ensuring consistency across organisations and over time. Some research organisations independently re-classify a significant sample of their awards and compare the results to control consistency of coding. Training of coders as noted above is important to maintain consistency and this should be supported by good documentation. Semantic technology has provided automated approaches to categorising research portfolios which in recent years have improved in their ability to reproduce and even sometimes exceed the quality of manual coding.

The DFG and ICRP are engaged in work to "translate" awards coded by the DFG's scientific discipline categories and CSO respectively into the HRCS. Approaches can be found to "translate" roughly 75% of awards coded using one system to HRCS directly, roughly 20% can be done through a semi-automated

41. In the frame of the ESF MO Forum on Research Infrastructures which was launched in early 2010 (http://www.esf.org/activities/mo-fora/research-infrastructures.html), the ESF coordinates the Mapping of the European Research Infrastructures Landscape project (MERIL EC FP7 GA # 262159): http://www.esf.org/activities/science-policy/research-infrastructures/meril-mapping-of-the-european-research-infrastructure-landscape.html
The European Strategy Forum on Research Infrastructures (ESFRI) currently run by the European Commission (EC) is a strategic instrument to develop the scientific integration of Europe and to strengthen its international outreach (http://ec.europa.eu/research/infrastructures/index_en.cfm?pg=esfri) (all websites accessed Nov-7, 2011)

system using keyword filtering and the remaining 5% may have to be re-coded manually[42]. These approaches may address the need to occasionally "translate" data into a common format for joint analysis. These approaches will be extremely important for analysis of research portfolios across organisations and across countries.

9. Support to evaluation programmes

Classification of research investment is a fundamental step in being able to evaluate progress, productivity and quality of research portfolios. An important consideration is how existing or new data on research output can be linked to research portfolio information for analysis. For instance, systems across two countries may be comparable in terms of categories and thus can answer questions about health research investment. However if the question posed is one not of health investment but research collaboration or scientific output, the challenge is to be able to link to other datasets, or to modify the existing system to add the evaluation metrics. For instance, the NIH's grants-to-articles linkage analysis evaluated scientific output of NIH grants based on existing research classification systems[43]. Ensuring that data on key evaluation metrics are linked to classification systems may inform similar analyses. The research information management systems in place (point 4 above), the unit of analysis (point 7 above) and also use of approaches to ensure data can be made inter-operable between systems (e.g. CERIF) are important considerations in this area.

42. Lynne Davies (ICRP) *personal communication*
43. Boyack KW and Jordan P. Metrics Associated with NIH Funding: A High-Level View. *J Am Med Inform Assoc.* 2011, 18(4): 423-431

Key characteristics of successful research classification systems

- **Simple**
  If the classification is to be applied manually then the number of terms and complexity of the system need to be kept to the minimum in order to be consistent. There is merit in constructing research-community driven approaches that make sense to a wide range of stakeholders from sponsors, governments and the public. Approaches able to capture the overall picture of the medical field will help with policy questions.
- **Relevant**
  The classification approach needs to be aligned with the research organisations' strategy, and there needs to be effort put into capturing the costs of implementing and maintaining the approach as well as the benefits of using classification. Organisations should consider how they are to use the classification system to drive operations, answer policy questions, support joint evaluation and so forth.
- **Consistent**
  Evaluation questions often need to examine trends over time; if classification approaches have changed significantly then these comparisons are difficult to make. The issue of quality control is important here, as results need to be reproducible. Sustainability is also important; there may need to be a wider "community of practice", exchange of staff and training material, opportunities to share best practice with other organisations.
- **Standardised**
  To allow comparison/analysis/evaluation of research funding and/or portfolios across funding agencies there needs to be a common language for classifying research portfolios; common definitions need to be applied in the same way.
- **Multi-dimensional**
  Classification needs to be done in at least two dimensions, such as subject area and stage of research development. Other dimensions that can be captured include the main disciplinary focus of applicants if this cannot be derived from their portfolio of awards.
- **Flexible**
  Classification systems are often reviewed regularly in order to be able to incorporate emerging areas. This may be possible at the sub-category level; however care has to be taken that the ability to track research trends over time is not lost and that approaches that are common between research funders do not diverge over time.

Recommendations

1. Use of the HRCS is encouraged as the leading approach for comparison and joint analysis of specifically *health* research portfolio information.

The HRCS is an approach which is gaining greater acceptance among research organisations that support health and health-related research. The HRCS is now in use, or is in pilot, in the UK (where over 20 research organisations have used it), Ireland, Sweden, Norway and outside of Europe in Singapore and Canada. Inclusion of both health categories and research activity dimensions has advantages in addressing policy and subject area questions. EMRC supports the use of the HRCS as a common system of choice for the analysis of health research portfolios, while recognising that research organisations are unlikely to discontinue systems which currently adequately support their operational processes. Organisations may wish to consider implementing the HRCS in order to participate in occasional joint analysis of European health research but may wish to do so just for particular years of spend.

2. Methodological developments are needed to reduce the cost of classification and increase flexibility.

More investment is needed in methodological developments that would overcome the challenges highlighted above in the 'Key limitations and challenges' section (page 12). Developing technologies such as fingerprinting (used by the NIH RCDC approach), natural language processing and support vector machines may now have progressed to the stage where they can provide significant efficiency savings over entirely manual approaches. The resources needed to classify research portfolios may be reduced to the point where whole portfolios and even archived past years of research funding can be quickly re-classified using automated methods. Advances in this area would allow organisations to switch between classification approaches so overcoming the fact that no single system will address all the requirements of a research organisation while also maintaining quality control and consistency.

3. Coordination of a common approach is needed across organisations at the national, European and international level.

The ICRP provides a good example of how a common approach can flourish over the long-term with central resources such as a database (in which portfolio information can be shared), a committee of participating research organisations and seconded expertise to run joint analysis. Encouraging a European network in this area appears a good route to facilitate the sharing of expertise and best practice and supporting the updating of guidance for classification. The aim should be to establish a "community of practice" for a common classification approach, which will work to discuss, agree and share guidelines for the continued, consistent operation of the approach. This work could be largely facilitated online with a "Wiki"[44] approach to updating training material and other documentation. It should be considered whether the ICRP database could be replicated for use as a shared repository of HRCS-coded portfolio information. In any case, a shared will among research organisations is needed to manage and coordinate a common approach. Central funding and support should naturally follow.

44. A "Wiki" is a website that allows the creation and editing of any number of interlinked web pages via a web browser using a simplified markup language: http://en.wikipedia.org/wiki/Wiki (accessed Nov-7, 2011)

Conclusion

The benefits of a common approach for classifying research portfolios applied across research organisations are clear. Classification helps research organisations keep track and evaluate investments or programmes and more generally research policies. Governments and funding agencies need to be able to assess their priorities and sometimes benchmark them. A common classification approach across research organisations assists in communication, identification of opportunities, benchmarking and collaboration.

A standard international classification system for health research does not necessitate individual agencies forfeiting their own particular classification systems: it may be implemented in parallel or there may be methods to map existing classification information to it or "translate" it to a more widely used categorisation system. Using automated approaches for classifying research has the potential to speed up work in this area, lower the cost of implementing classification processes and support the use of a common categorisation approach.

This briefing highlights the key characteristics of successful classification systems. EMRC recognises the strategic advantage that would be gained from being able to analyse medical research portfolios across Europe and is willing to strongly encourage work to implement a common international approach. EMRC will start the process of identifying ways for stakeholders to implement these recommendations by holding a follow-up workshop in November 2011. A clear workplan and timeline defining the next steps to be taken to implement the three recommendations at both national and European level should follow in early 2012.

These advantages equally apply to disciplines outside of medical research, and encouragement should be given to extend this approach to other disciplines. The ESF could address this via its other standing committees and expert boards and consider whether there is potential for further convergence.

Abbreviations

ABS: Australian Bureau of Statistics
AMRC: Association of Medical Research Charities
ANZSRC: Australian and New Zealand Standard Research Classification
ARC: Australian Research Council
ASRC: Australian Standard Research Classification
BBSRC: Biotechnology and Biological Sciences Research Council
BHF: British Heart Foundation
CCRA: Canadian Cancer Research Alliance
CERIF: Common European Research Information Format
CRIS: Current Research Information Systems
CRUK: Cancer Research UK
CSO: Common Scientific Outline
DFG: Deutsche Forschungsgemeinschaft
EC: European Commission
EMRC: European Medical Research Councils
EPSRC: Engineering and Physical Sciences Research Council
ERA: European Research Area
ESF: European Science Foundation
ESFRI: European Strategy Forum on Research Infrastructures
ESRC: Economic and Social Research Council
euroCRIS: European Organisation for International Research Information
EUROHORCs: European Heads of Research Councils
FoR: Field of Research
FOS: Field Of Science and Technology
FP: Framework Programme
FRIS: Flanders Research Information Space
GEPRIS: German Project Information System
HEIs: Higher Education Institutions
HRCS: Health Research Classification System
ICRP: International Cancer Research Partnership
LESC: Life, Earth and Environmental Sciences Standing Committee
MERIL: Mapping of the European Research Infrastructures Landscape
MeSH: Medical Subject Headings
MO(s): ESF Member Organisation(s)
MRC: Medical Research Council
NABS: Nomenclature for the Analysis and Comparison of Scientific Programmes and Budgets
NCI: National Cancer Institute
NHMRC: National Health and Medical Research Council
NIH: National Institutes of Health
NLM: National Library of Medicine
OECD: Organisation for Economic Co-operation and Development
RCDC: Research, Condition and Disease Categorization
R&D: Research and Development
RePORT: Research Portfolio Online Reporting Tools
RePORTER: RePORT Expenditures and Results
SEO: Socio-Economic Objective
ToA: Type of Activity
UKCRC: UK Clinical Research Collaboration
Wellcome: Wellcome Trust
WHO: World Health Organization

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ISBN: 978-2-918428-52-7
November 2011 – Print run: 1500