CARDIOSCape Report Summary

Project ID: 306086
Funded under: FP7-HEALTH
Country: France

Final Report Summary - CARDIOSCape (A survey of the European cardiovascular research landscape and recommendations for future research strategy)

Executive Summary:
› CardioScape - a survey of the European cardiovascular research landscape and recommendations for future research strategy - is a 23 month project funded by the European Union FP7 research programme.
› CardioScape aims to outline the current CVD research and innovation landscape across Europe towards establishing the extent of duplication across national research programmes and the existence of gaps that reduce opportunities for innovation.
› The lead CardioScape project partner is the European Society of Cardiology (ESC), representing over 80,000 cardiology professionals across Europe and the Mediterranean. Its mission is to reduce the burden of cardiovascular disease in Europe.
› PNO, Europe's leading independent innovation grants consultancy, is the second project partner. Founded in 1985, PNO is Europe's largest independent public funding advisory, annually raising over €250 million on behalf of its clients.
› 157 organisations from all EU Member States were invited to report information on the funding provided for cardiovascular research. The accurateness of the CardioScape data and of the analysis is based on the assumption that the information received was truthful.

CardioScape: the first-ever database on CVD research in Europe
› The CardioScape database provides a snapshot of cardiovascular research project grants ≥ € 100 000 for the period 2010 – 2012 in the EU.
› Although industry funding for cardiovascular research represents an important share of the overall available funding for research at a European and national level it was not possible to collect such data.
› An exhaustive inventory of EU funding for cardiovascular research was not within the scope of the CardioScape project. Information on FP7 funding in 2010, 2011 and 2012 is referenced as means of comparison with sources of national funding.
› European and national funding bodies and scientists from all areas of cardiovascular research may access the CardioScape database, which is freely available to the whole scientific community, to understand who is doing what research and where and funded by whom.
› Automatic computer classification allowed the continuous categorisation of new entries from different sources into the common CardioScape taxonomy of research.
› Using a web-based user interface, the data can be interrogated from very different viewpoints by different types of users (e.g. policymakers, funding bodies, researchers).
› Data collection, classification and interrogation processes developed for CardioScape could be expanded to other relevant areas of medical research in Europe.
› CardioScape is an incentive for researchers and funding bodies to include new data in the database, in order to maintain an up to date European picture of cardiovascular funding. Overall, this will improve the extent and quality of knowledge on cardiovascular research funded and performed in the EU.

CardioScape: a picture of the CVD research landscape in Europe
› At least €876 million was awarded for CVD research project grants under competitive open funding schemes in the EU over a
three years period (2010 – 2012)

› 2/3 (€ 618 M) of surveyed CVD research funding comes from national sources (government/public and charity/private), while the remaining 1/3 (€ 258 M) comes from the EU. National funding sources appear as key for research performed within national borders and find an important complement in EU funding that focuses on transnational cardiovascular research.

› 130 funding organisations, government/public and charity/private, fund CVD research across the EU-28

› Government/public funding in cardiovascular research in Europe accounts for 53% of total grants awarded, excluding EU funding. Charity/private agencies provide 47% of cardiovascular research funding in Europe.

› One funding agency alone, the British Heart Foundation, accounts for 14% of total funding in CVD research, including EU funding, and 22% of CVD research funding across EU-28 excluding EU funding.

› 3 funding agencies3 account for over 50% of nationally provided competitive grant funding dedicated to CVD research.

› Only 3 charity/private agencies have budgets higher than €10 million for CVD research in 2010-2011-2012

› 7 government/public agencies have budgets above €10 million for CVD research in 2010-2011-2012

› Although CVD is the most common cause of death in EU, research funding is larger for cancer: €2.25 billion over three years (latest available data from 2002-2003)

› Research spend is highest for the area of human/clinical research, which generally entails much higher costs than basic research, and lowest for research in prevention/population/public health.

Project Context and Objectives:
Cardiovascular diseases (CVD) - a grouping of diseases that affects the structure and/or function of the heart and blood vessels, including heart disease and stroke - is the world's leading cause of death, claiming 17.1 million lives each year. In Europe, CVD is responsible for the death of over 4 million people per year in 52 out of the 53 member states of the WHO European Region. Recent data indicates that up to 80% of all healthcare expenditure in Europe is allocated to chronic diseases, with cardiovascular diseases alone being estimated to cost the EU economy over 196 billion euro every year.1

As identified by the European Commission, by 2050 the number of people over 50 will rise by 35% and those over 85 will triple

The WHO has estimated that this rising life expectancy coupled with adverse trends in major cardiovascular risk factors including obesity and type II diabetes could lead to a doubling in the absolute incidence of CVD by 2050. Thus, finding new approaches to screening and prevention, early detection and management, new and innovative treatments and effective and cost effective service delivery to enable people to live healthily, longer and independently will be essential for the quality of life of all citizens and for the sustainability of EU healthcare systems where costs are expected to rise exponentially.

CVD research is not only a crucial area in health research overall, but could become an outstanding example of research driven innovation across Europe, which, through better understanding of the causes of CVD, the development of new medicinal products and the improvement in medical technology, will boost scientific excellence and create new knowledge as drivers of future growth and prosperity. To achieve this research potential we need to better understand the existing CVD research landscape, engage with different actors from academia and industry to shape more effective research strategies, ultimately leading to better technological, therapeutic and preventive strategies for patients and populations.

Regrettably, a clear portrait of the CVD research landscape in Europe did not exist before this project. This affected researchers’ work which is exposed to high levels of duplication and fragmentation of research efforts and generally suffers from the overall lack of a coordinated approach. The current fragmentation of public research programming leads to sub-optimal R&D returns and is a drain on Europe's increasing limited financial resources in these recessionary times, and prevents it from realising its societal objectives.

CardioScape explored the European CVD research landscape, building on the partnerships that the European Society of Cardiology has been mobilising over recent years in order to facilitate cross-disciplinary alliances and foster the collaborative approach, which is seen as the key to innovation in health care and disease prevention.
Research funding

Overall research funding in Europe (1.8% of GDP) falls well below that of the US (2.6%) and Japan (3.3%). In Europe 85% of public R&D funding is being provided at national level, with less than 6% of total R&D investment being financed in a cross-border collaborative manner.

EU funding for health research currently represents less than 10% of the overall EU research budget, with the US investing on average 3.5 times more than the EU in health research. For example, CVD research was granted €123M for the first 4 years of FP7 while in the US the NIH dedicated €550M in 2010 alone.

Funding for CVD research comes from three main sources – public funding, the pharmaceutical and medical device industries, and private non-profit foundations, with considerable variation evident across European countries. The share of public funding for health research ranges from 24% in the UK to 63% in Germany, while industry’s share in the overall funding is lowest in Germany with 35% and highest in Sweden with 66%.

Private foundations contribute only 1% to health research funding in Germany but 10% in the UK. This data illustrates the considerable variation in health R&D funding strategies prevailing across the different European countries.

CardioScape built on and developed the existing comprehensive European Society of Cardiology (ESC) constituent network, seeking to include actors from academia, industry and EU and national policymakers to help identify the most important research needs and funding gaps that will support more efficient valorisation of project results and better foster the transmission of new scientific findings into clinical practice.

Objectives

The CardioScape project aimed to carry out a survey of the European CVD research landscape, from which expert opinion could guide investment into identified research gaps, highlight areas where coordination could be improved, and help prioritize future research.

CardioScape identified CVD research projects in the EU28. Projects will be tracked at both a European and national level, where the support of National Societies of Cardiology was crucial.

Specific objectives were as follows:

1. Survey research activities and funding for CVD research, both public and private, at national and European level

The CardioScape survey targeted EU funded projects, European and national organizations offering research support, national state funded projects, industry funding and charitable organisations, including investigator driven research projects, academia led research projects and academia/industry and public/private consortia.

2. Create a CVD research and funding database based on the survey results.

The objective was to translate the paper questionnaire in an online format, allowing respondants to fill in their forms online. The objective was also to develop a dedicated database to contain all data collected through the paper and online CardioScape questionnaires from European & national sources on CVD research and funding.

The database is publicly accessible from the CardioScape dedicated project website, developed by the ESC IT team.

Research and funding data include:
- Research project titles and corresponding funding agency
- Countries where research is carried out and origin of funding
- Research areas, scope – broad health/CVD area or sub-specialised CVD topics
- Research aspect – basic, investigative, clinical, epidemiological
- Funding amounts
- Project duration

3. Assess and identify by expert analysis the gaps, strengths, weaknesses and opportunities in European CVD research
The compiled data collected at both national and European level, from researchers, research centres and funding agencies compose a clear inventory of research efforts related to CVD in Europe. This analysis and assessment work was carried out by the CardioScape Scientific Committee overseen by the CardioScape Steering Committee. The Scientific Coordinator ensured consistency and coordination between these two bodies.

4. Identify and evaluate CVD research funding sources
In tandem with the above objectives, which, as seen, involve the survey and mapping of current CVD research and funding activities at researcher/research centre level, the key aspect of funding programme availability and uptake was further developed and corroborated by a more comprehensive view of the EU and national funding landscapes for CVD research, a task managed by PNO.

PNO used their knowledge and experience of the European funding and innovation landscape as a starting point for their in depth analysis. During the project they evaluated the existing EU and national funding landscapes relating to the CVD research area, as follows:
Identification of European private and public funding
- European organisations offering research support
Identification of national private and public funding
- Charitable organisations
- Regional support organisations
- Business support organisations

The research considered all of the EU28 countries. The two parallel activities performed by the partners ensured that as many funding organisations and schemes as possible where identified. The original plan also included investigation funding offered by industry. However during the course of the project it became apparent that industry preferred to keep details of the projects funded confidential, and funding was either targeted or offered on a case by case application, as opposed to being through open calls.
This separate funding study will complemented the research questionnaire survey studies by highlighting the awareness level of the researchers on the ground of the available various funding programmes and identifying which programmes work best in practice and offer the best chance of success.

The output of this work was a 600 page report detailing the funding bodies and schemes that could potentially be accessed by industry and/or academia to support research in the area of CVD.
The individual funding schemes were further broken down into 1 page documents, available for view and download from the Cardioscape website on a per country basis.

5. Propose recommendations and future strategy for CVD research in Europe.
Based on the analysis of the CVD research landscape, the cardiology community and related stakeholders, in particular industry partners and academia, enunciated clear recommendations for research areas where special efforts need to be deployed and where public funding needs to focus, hence guiding priorities to be addressed within Horizon 2020 – the
The cooperation between the Scientific Committee and the Stakeholders Group ensured that the recommendations were not solely developed from the perspective of the cardiology profession, but benefited from a broader vision represented by the experience and wisdom of a range of stakeholders involved in various facets of medical research. A blueprint report detailing such recommendations for a more effective and coordinated European CVD research strategy was published and widely disseminated to various stakeholders including European and national policy makers and funding agencies. It is the ESC objective that such recommendations will serve as the basis for future CVD research related project, supporting the EC drive towards the Horizon 2020 CSF.

6. Disseminate effectively the project results to the CVD research community, the various stakeholders and the wider public; relating to both the existing mapped research and funding landscape and the future recommendations for a more effective coordinated research approach.

An interactive project website will be designed and developed by the ESC to present CardioScape which will be updated regularly with relevant information. The ESC used its communication tools to disseminate the conclusions and recommendations of the CardioScape project, with a dedicated session and meetings at the ESC Annual Congresses, publications in peer reviewed journals, dissemination via the CRT membership, press releases to medical media, communication to sister organisations of other medical specialties, industry contacts, EU and national policymakers, etc.

CardioScape dissemination activities were undertaken through the following principle channels:
- Publications and press releases
- Consortium participation in conferences, workshops and European events
- Social networking, including Youtube and Twitter
- Networks and collaboration
- Newsletters
- Websites (including partners, networks and dedicated project)
- Brochure
- Conferences, workshops, seminars, forums

The results of the CardioScape project were widely disseminated to all interested target groups through active e-mail campaigns. A wide range of individuals and groups were contacted to promote the CardioScape project. These included universities, public research centres, charities, sister organisations of other medical specialties, industry contacts, EU and national Policymakers

The brochure, with the CardioScape summary of project findings, is a 24 page, full colour gloss print. It introduced CardioScape, presented the results of the research funding landscape, analysed demographics and distribution and funding levels. Finally the brochure explored the key findings, conclusions and recommendations. It also promoted the CardioScape database and encouraged CVD researchers and funding bodies not only to use the database but also to continue to contribute to it by sending in information.

The workshops and events promoted the CardioScape project and created a network of relevant stakeholders with whom the Consortium will actively involve in the commercialisation and dissemination of project results after project end.

ESC hosted CardioScape promotional videos on their channel ‘ESC TV’, which has 1,677 subscriber (Sept 2014). CardioScape has also been promoted in the National Cardiac Societies Presidents newsletter, which is sent every two weeks to the 56 national cardiac societies members of the ESC.

The project website is hosting the database, and the ESC is taking internal measures to keep the database constantly updated, while seeking support from the CVD research community for external funding.
Project Results:
The following section details the S&T results of CardioScape:

CardioScape database
A dedicated web database was developed to store and present data collected from funding organisations involved in CVD research. The database was initially useful to CardioScape experts for their analysis of the current CVD research landscape and is now available to all from the CardioScape website, hence allowing researchers, funding organisations and industry to interrogate the database to find relevant and updated information on CVD research in Europe.

The database was designed to easily and quickly find information related to CVD research related projects funded in Europe. Search fields allow different types of queries, including:

- **COUNTRY**: the search can be done at the level of one country, several countries or all EU countries together.
- **RESEARCH AREA**: this field allows an automatic sort of projects divided in three research areas: basic/preclinical research, human/clinical research and epidemiology/population/prevention research.
- **RESEARCH TOPIC**: this field is based on the CardioScape taxonomy.
- **FUNDING AGENCY**: the field allows searching for funding agencies one by one or several together. The search field prompts a drop down menu listing all agencies that populate the CardioScape database.
- **YEARS**: The CardioScape database allows searching for projects running in 2010, 2011 and 2012. However, the database also contains projects awarded before and after this time period, which have been submitted by the stakeholders.
- **FUNDING AMOUNT**: two search fields allow searching for projects by their funding amount defining a minimum and/or a maximum amount.
- **KEYWORDS**: including the AND, OR and NOT functionalities allows combining several keywords or excluding others.

All search fields can be combined for an advanced search. The results are displayed in columns by projects and the first results page indicates the number of projects found for each search.

The database is populated with information providing from 130 organisations, which responded to the CardioScape questionnaire. It contains data on 2476 research projects, with information on the following:

- Research project titles and corresponding funding agency
- Geographical coverage of the project
- Number and type of partners
- Research area (basic, clinical, epidemiological)
- Research topics, based on taxonomy developed for the project
- Total Funding awarded
- Project duration

The database is a wealth of information for the whole cardiology research community; it is the first ever database on CVD research in Europe.

CardioScape taxonomy
In parallel, a detailed taxonomy of research content was created in order to facilitate the analysis of data (see attached pdf). All projects were initially classified into three broad areas: epidemiology/prevention/public health, basic/preclinical or clinical/human research, based on the respondents’ indications. A hierarchy of terms was developed so that major topics and sub-topics could be assigned to each project according to project details provided by the funding agency. The number of terms assigned to each project depended on the details provided by the funding body and ranged from only a project title to a complete outline of the planned project.

The categorisation of the data collected in the database was performed in collaboration with an ad-hoc ‘Classification Group’ composed of three young fellows in cardiology, who were responsible of developing a unique research taxonomy based upon the topic list of the ESC congress abstracts and the topic lists and keywords from each of the six ESC specialty journals.

The taxonomy is a unique effort, very well received by the funding organisations that were part of the CardioScape Stakeholders group.
CardioScape inventory of available funding sources

Thanks to CardioScape, the community of European researchers also has access to a wealth of information related to funding opportunities for their research projects. PNO’s inventory of funding sources is available from the CardioScape database, with detailed information on funding schemes, for each of the European Union countries, which could be suitable for research and innovation related to cardiovascular disease research in Europe. This inventory is of interest in particular to young investigators, and is contributing to making Europe more innovative in medical research.

CardioScape findings

NB: for this section, please refer to attached pdf document named “Figures & Graphs_CardioScape S&T results” for visuals.

I. INFORMATION COLLECTION

• 157 organisations from all EU-28 Member States were contacted
• 130 organisations responded to the questionnaire
• 48% provided a complete response
• 35% organisations did not meet the CardioScape criteria (i.e. had not funded projects in the last three years (22%) and/or awarded grants ≥ € 100 000 (13%)
• 11% refused to provide any information
• 4% provided incomplete information (e.g. missing abstract, no budget indication by project)
• 2476 research projects were included in the CardioScape database

II. CARDIOSCAPE DATABASE

Not all submitted projects fell within the scope of CardioScape (i.e. projects awarded during the years 2010, 2011 or 2012 with a budget ≥ €100,000). Other projects, awarded before or after the CardioScape period of analysis or with lower budgets, and for which data was provided, all appear in the CardioScape database but were excluded from the analysis. The CardioScape database, accessible on the CardioScape website, is being updated with new data received from funding organisations and investigators. Any corrections required to any of the data appearing on the CardioScape website can be notified to the ESC.

III. GENERAL ANALYSIS

The CardioScape survey shows that at least €876 million was awarded to cardiovascular disease research in the EU-28 in 2010, 2011 and 2012 under the funding schemes examined. Excluding EU funding, government/public funding account for 53% of total funding, charity/private agencies provide 47% of cardiovascular research funding, adding up to € 618 million. Overall EU funding alone accounts for 30% of overall cardiovascular research funding in Europe. Strategic research funding directed at institutions or specific research consortia within a national context is not included in the CardioScape project. Following breaking down the grant into annual awards, CardioScape data indicate that a large majority of projects (70%) have an average grant level of €100,000 or less per year.

IV. GEOGRAPHICAL ANALYSIS

Based on the data submitted by the contacted funding agencies, the UK appears to be the dominant country in the European CVD research funding landscape, followed by Germany.

In Romania and Malta, no funding organisations were identified by the experts nominated by the National Cardiac Societies. In Bulgaria, Cyprus, Croatia, Estonia, Lithuania and Portugal no funding > € 100 000 was available for CV research in the period 2010-2012. FP7 projects funding is not included in Fig. 2 & 3 shown in attached pdf file.

V. DEMOGRAPHIC ANALYSIS

CVD RESEARCH FUNDING VS POPULATION
The CardioScape analysis shows that there is no or little relationship between the total national funding and a country’s population size. Countries with powerful charity/private organisations and/or fund raising cultures and activities (UK, Ireland, Netherlands, Sweden) appear to have a far greater ratio of CVD research spending per capita.

CVD RESEARCH FUNDING VS CVD MORTALITY
Figure 5 shows that the level of CVD research funding is not proportional to the CVD mortality rates. Eastern and Central European countries, where CVD causes up to 50% of deaths for both men and women (e.g. Bulgaria, Romania) have little if any health research dedicated to CVD within the funding schemes examined. On the contrary, project funding dedicated to cardiology and CVD research is high in North and Western Europe, where CVD mortality has significantly fallen over the last decades. The reason behind this observation presumably lies in the economic development of the countries: the poorer the country, the less available R&D funding.

VI. ECONOMIC ANALYSIS
Figure 6 shows the relation between CVD research project funding by country and the Gross Domestic Product (GDP) per capita. Not surprisingly, there is an obvious correlation between each country’s wealth (GDP) and the amount of funding dedicated to CVD research.

VII. DISTRIBUTION OF FUNDING BY RESEARCH AREA
CardioScape shows that total funding awarded is highest for human and clinical research and lowest for epidemiology/population/public health research.

The number of research projects funded is similar for human/clinical and basic/pre-clinical and smallest for prevention/population/public health, indicating the size of grants is considerably larger in the human/clinical field.

By adding data on European Union Framework Programme 7 (FP7) projects under the collaboration scheme, CardioScape shows that EU funding is almost 5 times greater for human/clinical research than for basic/preclinical research. This is explained by the clear focus of FP7 on translation, including clinical research and public health. EU FP7 funding for epidemiology/population/public health is less visible in the database, because of projects’ classification resulting as clinical research in a primary label. In addition, it is to be noted that data from the EU Public Health Programme do not appear in this survey. During the 2010-2012 period, the European Union co-funded the EuroHeart II project worth €2.7 million, including a European Commission contribution of €1.023 million.

Regarding basic research, cardiovascular topics may have been included under IMI and ERC programs, not included here.

The distribution of CVD research projects by research area in each EU country varies widely and is highly dependent on the number of projects collected for each country. However, the European landscape country by country is dominated by human/clinical research.

In Romania and Malta, no funding organisations were identified by the experts nominated by the National Cardiac Societies. In Bulgaria, Cyprus, Croatia, Estonia, Lithuania and Portugal no funding > € 100 000 was available for CV research in the period 2010-2012. FP7 Projects funding is not included.

VIII. ORIGIN OF FUNDING

The CardioScape survey describes the origin of project funding and provides some understanding of who are the bigger funders of CVD research in Europe and what their research focus is.

Charitable funding dominates the picture of CVD research in the UK.

IX. TOP 10 FUNDING ORGANISATIONS (PUBLIC & PRIVATE)

The CardioScape survey shows vast differences between budgets allocated to cardiovascular research funding by funding agencies, whether charity/private or government/public.

Only three private agencies have budgets higher than €10 million for CVD research in 2010-2011-2012, while seven
government/public agencies have budgets above this threshold.

X. DISTRIBUTION OF FUNDING BY RESEARCH TOPIC

This section describes what topics are funded by CVD research in order of priority, with the objective of identifying areas of research that are less funded.

Topics and sub-topics are based on the CardioScape taxonomy. While projects usually have only one main/parent topic, they may have several sub-topics, e.g. atrial fibrillation, channelopathies and electrical cardioversion are some of the sub-topics of the main/parent topic arrhythmias. The automatic classification developed by the Berlin-based Charité University for CardioScape ensures that projects can be mapped back to one main topic based on a series of criteria.

Identified topics have also been classified within three main areas of research: basic/preclinical research, human/clinical research, epidemiology/prevention/public health research.

› Top 10 most funded topics by area of research

The CardioScape database allows to identify the the top 10 topics funded across Europe, for each area of research (see figures 12, 13 and 14 in attached pdf file.)

XI. COMPARISON WITH RESEARCH SPEND FOR OTHER NON-COMMUNICABLE DISEASES

Although CVD is the most common cause of death in EU, research spend is substantially larger for cancer research with €2.25 billion over 3 years (data 2002-2003). Of course, to make comparisons to other non-communicable diseases requires contemporary data of the same quality and this information is not readily available. Expanding the CardioScape approach (data gathering, data analysis, database access) to other fields would be a good option to obtain such data.

CardioScape recommendations

› General Recommendations

CardioScape’s findings emphasize the importance of both national and transnational funding to address the pan-European burden of cardiovascular disease. The data provide strong incentives for continued investment in cardiovascular research. Whereas some gaps in the focus of CV research funding were highlighted, major duplication could not be detected in the analysed period 2010-2012. Of course, gaps may have been filled in the following years, but their existence suggests that inequalities in research funding do exist and should not be disregarded. Duplication may also have arisen in the years following the analysed period: this recalls the importance of maintaining and further developing the CardioScape database to make it a useful resource for strategic research planning.

Further analysis is needed to understand whether the wide disparity in the level of funding between different nations reflects differences in the stages in the translational research pipeline supported by each type of funder. Although industry funding for cardiovascular research represents an important share of the overall funding provided at a European and national level it was not possible to include such data in the CardioScape project. We recommend that this shortcoming is addressed in future by further dialogue with industry, so that non-confidential summary information (of the kind presented in this report) can be used to aid funders and researchers.

CardioScape’s findings should be interpreted cautiously, because there is not necessarily a strong correlation between the level of funding for a specific topic and the impact this has on human health and the wealth of the economy. Evaluation of the impact of research on health and wealth is complex, partly because of the time lag between scientific discovery and clinical benefit and needs different tools for analysis. A study performed by the MRC indicated that in particular in cardiovascular disease the return on investment is highly significant . Methods for the evaluation of impact of research on health and wealth of EU population need to be further developed and applied to update these earlier observations.

The CardioScape database will increase in value substantially if it is maintained and developed further to become an essential and unavoidable EU cardiovascular research inventory, enabling improved decisions about research priorities and research funding both at the EU and national level. We propose that funders should co-operate to continue to populate this unique database with awarded research grants on an annual basis and to make this information freely available to all funding bodies,
academic institutions and scientists. Additional information, such as the primary investigator of each research project, could be included.

The success of the CardioScape survey process indicates that this methodology could be used to gather similar data in other areas of medical research with high economic significance in the EU (e.g. cancer, neurodegenerative disease, metabolic syndrome, diabetes).

The use of CardioScape Taxonomy of Research, which has been developed based on the ESC Congress abstract topic list and the topic list of the ESC journals, could be extended for use by all CVD research funding agencies, with the objective of obtaining one single in-depth classification of CVD in Europe. This taxonomy would be updated on a regular basis, based on new discoveries and scientific developments.

CardioScape recommends to develop the relationship between the main cardiology-related publishers and online archives of medical papers, to encourage collaboration and allow users, of both CardioScape database and publishers database, to easily consult one from the others, and vice versa.

Research-specific Recommendations

• AGEING - Based on the information contained in the CardioScape database, despite the current ageing of the population and the large changes that occur in the cardiovascular system with ageing, the amount of research efforts funded in Europe evaluating the prevention, causes, occurrence and treatment of cardiovascular disease in the elderly and their association with the ageing process is very limited (20 projects) and thus deserves further evaluation and consideration for funding. Within the H2020 calls, there is no disease pre-specification in this area and this requires attention to ensure including cardiovascular disease.

• CARDIOVASCULAR NURSING - Funding of research in the area of cardiovascular nursing was found to be scarce. In particular, no projects address nursing education neither in human/clinic nor in epidemiology/prevention research areas. The available funds are located on a national level and support relatively small projects. To deliver optimal patient care and to support healthcare staff of all disciplines in the decision-making process, evidence-based nursing practice is a prerequisite and support for research in cardiovascular nursing is needed.

• COMPUTER MODELLING & COMPUTERS IN CARDIOLOGY - In the two related areas 'Computer modelling' and 'Computers in cardiology' the CardioScape database reports a sizeable number of funded projects (22 and 128), evidencing broad and competitive scientific activity in the field. A main component of the computer / modelling approach to cardiovascular medicine or medicine as a whole is the development of a patient specific understanding of pathophysiological mechanisms and tailored treatment options. This approach was initiated by the EU in the STEP process in 2005 and is funded via the ‘VPS’ (virtual physiological human) programme. Despite the significant number of funded projects in the area, however, this approach has not entered the ‘mainstream' of cardiovascular science or even practice. Thus, its potential is grossly underused. This is evident, e.g. by the low representation if related events at the ESC conferences. Here, a lack of structural and strategic funding is evident, which would be aimed at bringing the individual approaches together, increasing the scientific discussion and translating the results into clinically testable concepts. Such funding would have to be supranational and should not so much target individual research projects, but corroborate the strength, interaction and visibility of the field by supporting conferences, career options and translational efforts.

• GENDER – Only 20 projects in the CardioScape Database include gender as a keyword. This confirms that gender aspects are not a key priority in cardiovascular research projects. CardioScape thus recommends that gender aspects are systematically addressed in cardiovascular research.

• HEART FAILURE - In the field of heart failure (HF), there are 2 major unsolved issues: the classification and treatment of patients hospitalized for acute HF, and the classification and treatment of patients with chronic HF and preserved ejection fraction. Analyzing the CardioScape database, it seems that HF is a clinical area with lot of studies (212), but just a minority of them are focused on the most relevant unmet needs: one study specifically focused on chronic HF with preserved EF and five studies on acute HF.

• METABOLOMICS - The application of systems biology could permit a better identification of the etiogenesis and pathological pathways leading to CVD. Such data could lead to a novel taxonomy of cardiovascular disease and support better directed treatment. In this regard metabolomics could play a role in improving the diagnostic and predictive capacity to detect CVD as well as provide information regarding potential etiological pathways that could be targeted for treatment. Overall, although
there are not many funded projects on metabolomics (23 results), many of these received large amounts of funding, suggesting the presence of a few large collaborative projects in Europe focused on metabolomics. Further efforts are needed in maintaining the current projects focused on using OMICs technologies for CVD and on translating these findings to facilitate their incorporation in clinical practice

• PLATELET FUNCTION AND ANTI-PLATELET TREATMENT - In the area of research on platelets there is a need for a geographical widening of research activity as the CardioScape database only lists activities in seven EU countries. There is also very limited publicly funded clinically based research on healthy volunteers or patients exploring newer modes of platelet function testing or the use of new anti platelet treatment strategies.

• PREVENTION - The amount of projects funded and resources allocated specifically to research on primary prevention in Europe is scarce (only 16 projects, the largest grant being € 1.7 M). This finding is quite worrying considering that industry funding is generally not directed to epidemiology/prevention/public health research. Population based registers of major cardiovascular events are rare; after the experience in the MONICA register (MONItoring of trends and determinants of CARDiovascular disease) coordinated by WHO in the eighties and nineties, there have been no further attempts to describe the burden caused by acute myocardial infarction in terms of morbidity, mortality and case fatality, at the level of the European population. Hospital-based registers illustrate only the top of the iceberg. There is an urgent need for new population-based observational cohort studies in order to develop more accurate and up to date models to estimate the total CV risk in the apparently healthy population; community-based intervention trials regarding the efficacy and safety of lifestyle- and environment- related exposures are needed to develop evidence-based health policies in the field of preventive cardiology. There remain a lot of unresolved problems as to the most efficient strategy to prevent CVD at the level of the community. Research should be carried out on the implications of the changing CV mortality pattern and of changing the time course of CVD in order to plan health services. Such studies need collaborative research by networks of epidemiologists and public health workers with special interest in CVD. Further efforts are necessary to improve the amount of funding directed towards prevention of CVD.

• REGENERATIVE MEDICINE/STEM CELLS - In general, this field was well funded with more than 200 projects and € 25 M of funding over 3 years. However, some aspects in this field have not been adequately addressed and should receive more funding in the future. This includes: 1) Stem cells (iPS) as models for cardiac development, because these cells undergo all steps from pluripotency to cardiac myocytes. 2) Tissue engineering for myocardial regeneration is a promising field because the effects of cells can be controlled ex vivo. 3) Finally, since no clinically applicable strategy of stem cell transplantation for cardiac regeneration has been established yet, more focus should be directed towards endogenous regeneration through cell cycle activation strategies of myocytes or transdifferentiation strategies of nonmyocytes.

• STEMI - Exploring the data base on the topic “ST-segment-elevation acute coronary syndrome (STEMI)” nine projects funded for a total of >2 700 000 EUR were identified. In 2010-2012 most of the funding in STEMI seems to go to studies on ischaemia/reperfusion injury. None of these studies has resulted in a guidelines recommended treatment. Collaboration among institutes with a common interest in ischaemia/reperfusion injury would results in a more cost-effective approach and hopefully an effective treatment.

Potential Impact:
The potential impact of CardioScape may take multiple forms and there are already very concrete examples of how CardioScape is contributing to shaping Europe.

By guiding future research priorities:
The CardioScape leaders have been in contact with the Federal Ministry of Education and Research (Bundesministerium für Bildung und Forschung, www.gesundheitsforschung-bmbf.de) to explore possibilities to apply for an ERA-NET on CVD in 2015 as part of the Horizon 2020. The CardioScape database and recommendations could be both of interest to support the development of the ERA-NET on CVD.

Fostering research in Europe will ultimately result in direct benefits to the European people, who will avail of medicinal products and medical treatments resulting from scientific excellence and knowledge, as well as to the EU economy. There is clear evidence that research yields economic returns, both through improved health gains (a healthy workforce) and through
commercial exploitation of research outputs. In 2008, a UK study demonstrated that the health and Gross Domestic Product (GDP) gains derived from the country's public and charitable investments in biomedical research are equivalent to an annual rate of return of about 39% for cardiovascular diseases. The study also found that public and charitable funding of medical research encouraged greater investment from the pharmaceutical industry.

Europe is seeking to move faster towards creating a true European Research Area (ERA) and will continue on this pathway in the upcoming Horizon 2020 programme, an initiative that is welcomed for the focus it brings on promoting better coordinated and harmonised research, increased excellence in the science base, and more effective use of funds invested. CardioScape can play an important support role in this quest in the CVD health research domain. CardioScape is currently used as a potential source of data to inform and undertake a case study linking funding to the publication output of cardiovascular research in Europe. This research on the global evolution of cardiovascular disease research is led by “Cardiovascular Research”, the international basic science journal of the European Society of Cardiology.

The CardioScape secretariat has been repeatedly collaborating with the Mapping NCD project partner in charge of collecting data on CVD research projects in Germany, Austria and Switzerland, Technische Universität Berlin, in an effort to avoid duplication by sharing information collected by CardioScape and likely to be of interest to the Mapping NCD project.

By fostering translational research:
The Structural Bioinformatics Group of the Charité Medicine University in Berlin (DE) used data collected in the CardioScape database to develop a test version of an online interactive map, showing CVD research centres in Europe with their contact details. Such interactive map could be of interest to scientists to easily find research partners and/or funding sources in a given geographical area in Europe.

By fostering innovation:
The inventory of funding schemes across Europe, available from the CardioScape website, is a paramount tool for researchers, giving them in one click a clear overview of all funding opportunities for research in their countries, with relevant information concerning funding rates, conditions and criteria. Such inventory will contribute to boost innovation in Europe.

By understanding CVD mechanisms & causes:
Further update and analysis of an updated CardioScape database will ultimately lead to the more efficient accumulation of new information that contributes to the development of better therapeutic, technological and preventive strategies, including trends over the years.

List of Websites:
www.cardioscape.eu

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